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ABSTRACT

A model of computer managed instruction is reported which emphasizes the use of the Wisconsin System for Instructional Management (WIS-SIM) in classroom level decision making. Two major decision areas, specifying performance expectations and selecting appropriate educational experiences, were identified, and five major processes involved in WIS-SIM were specified: testing, achievement profiling, diagnosing, prescribing, and instructing. The WIS-SIM model was applied to two of the Wisconsin R & D Center's instructional programs--the Wisconsin Design for Reading Skill Development and Developing Mathematical Processes. A summary of the implementation schedule, identifying three successive annual applications of WIS-SIM is also presented. (Author/WH)

Working Paper No. 125

COMPUTER APPLICATIONS IN INDIVIDUALLY GUIDED EDUCATION: A COMPUTER-BASED SYSTEM FOR INSTRUCTIONAL MANAGEMENT (WIS-SIM)

Needs and Specifications

by

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Report from the Project on
Computer Applications for IGE

Wisconsin Research and Development
Center for Cognitive Learning
The University of Wisconsin
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STATEMENT OF FOCUS

Individually Guided Education (IGE) is a new comprehensive system of elementary education. The following components of the IGE system are in varying stages of development and implementation: a new organization for instruction and related administrative arrangements; a model of instructional programing for the individual student; and curriculum components in prereading, reading, mathematics, motivation, and environmental education. The development of other curriculum components, of a system for managing instruction by computer, and of instructional strategies is needed to complete the system. Continuing programmatic research is required to provide a sound knowledge base for the components under development and for improved second generation components. Finally, systematic implementation is essential so that the products will function properly in the IGE schools.

The Center plans and carries out the research, development, and implementation components of its IGE program in this sequence: (1) identify the needs and delimit the component problem area; (2) assess the possible constraints--financial resources and availability of staff; (3) formulate general plans and specific procedures for solving the problems; (4) secure and allocate human and material resources to carry out the plans; (5) provide for effective communication among personnel and efficient management of activities and resources; and (6) evaluate the effectiveness of each activity and its contribution to the total program and correct any difficulties through feedback mechanisms and appropriate management techniques.

A self-renewing system of elementary education is projected in each participating elementary school, i.e., one which is less dependent on external sources for direction and is more responsive to the needs of the children attending each particular school. In the IGE schools, Center-developed and other curriculum products compatible with the Center's instructional programing model will lead to higher morale and job satisfaction among educational personnel. Each developmental product makes its unique contribution to IGE as it is implemented in the schools. The various research components add to the knowledge of Center practitioners, developers, and theorists.

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ABSTRACT

A model of computer managed instruction is reported in this paper. The Wisconsin System for Instructional Management (WIS-SIM) focuses on providing information to educational decision makers. Two major decision areas, specifying performance expectations and selecting appropriate educational experiences, were identified, and five major processes involved in WIS-SIM were specified: testing, achievement profiling, diagnosing, prescribing, and instructing. The first process, testing, is directly related to initiating and updating a student data base. Achievement profiling, diagnosing, and prescribing utilize the data base in generating reports useful in making instructional decisions, and instructing is the process for carrying out the prescribed plan and implementing the selected appropriate educational experiences.

The WIS-SIM model was applied to two of the Wisconsin R & D Center's instructional programs--the Wisconsin Design for Reading Skill Development and Developing Mathematical Processes. Detailed plans for system development in these areas, including mock-ups of input forms and reports to be generated, are presented.

A summary of the implementation schedule, identifying three successive annual applications of WIS-SIM is also presented. Each successive testing of the system will be expanded in curriculum coverage and the number of schools involved. Both on-line and batch systems will be implemented and evaluated.

This report emphasizes the use of WIS-SIM in classroom level decision making. A future report will expand the scope of the system to consider decision making at organizational levels other than the unit or classroom, potential research applications, and report-generating capabilities for parental use.

I

INDIVIDUALLY GUIDED EDUCATION AND A MODEL FOR A COMPUTER-BASED SYSTEM FOR INSTRUCTIONAL MANAGEMENT

INTRODUCTION

The research, development, and implementation thrust of the Wisconsin Research and Development Center for Cognitive Learning is focused on Individually Guided Education (IGE). The main features of IGE are (1) attention is focused on the individual learner; (2) systematic problem solving is applied by educators to educational problems; (3) unit structure is employed to provide a healthy group size for learning; (4) staff training is made an essential part of the approach; and (5) autonomy and accountability are kept in balance (Chase, 1972). The following components of the IGE system are in varying stages of development and implementation: a new organization for instruction and related administrative arrangements; a model of instructional programing for the individual student; and curriculum components in prereading, reading, mathematics, motivation, and environmental education. Initial Wisconsin R & D Center activity has focused on developing programs and devising structures within the context of IGE for elementary education. However, a need for a secondary-level application of IGE has now been identified.

IGE requires that complex decisions be made by classroom teachers concerning the individual educational experiences to be prescribed for each student. Computerized systems for instructional management allow for more complex and more comprehensive evaluation of information for decision making related to the instructional program, leading to more effective implementation of the IGE program.

Computers also provide an effective means of monitoring student progress on a systematic basis and increase the time available for teacher-student interaction by relieving the classroom teacher of routine clerical tasks. In addition, computerized systems provide a practical means of obtaining assessment data to evaluate school district programs in relation to major educational objectives. The design and evaluation of a system for computer management of the curriculum components, the instructional strategies, and the administrative arrangements of IGE is a long-range developmental activity of the Wisconsin R & D Center.

This needs and specifications paper reviews the major components of IGE developed by the Wisconsin R & D Center, including the instructional programing model, and identifies the major management requirements of this model. Also reviewed are previous conceptual and developmental efforts in computer managed instruction. These two reviews provide a basis for the development of a model for a computer-based System for Instructional Management (WIS-SIM). Predevelopment computer management design efforts on fairly mature components such as Individually Guided Motivation (IGM), the Wisconsin Design for Reading Skill Development (WDRSD), and Developing Mathematical Processes (DMP) are currently underway. The predevelopment design efforts in WDRSD and DMP have been responsive to the requirements imposed by IGE, IGM, and the instructional programing model. The differential requirements of WDRSD and DMP and the impact of those two major components on system design will be highlighted.

Projections of the impact of less mature components, such as the Prereading Skill Program, IGE at the Secondary Level, Environmental Education, and Home-School-Community Relations, will be made. System design goals based on currently known IGE requirements and the strategy for making computer management available to a large number of IGE schools will be discussed.

IGE AND THE INSTRUCTIONAL PROGRAMING MODEL

IGE is a comprehensive system of education and instruction designed to produce higher educational achievements through providing for differences among students in rate of learning, learning style, and other characteristics (Klausmeier, Quilling, Sorenson, Way, & Glasrud, 1971).

IGE is more comprehensive than individual instruction, when individual instruction is viewed as each child proceeding at his own rate through interacting on a one-to-one basis with a teacher or directly using instructional materials or equipment. Much instruction in the IGE system takes the form of a teacher instructing small groups of 8 to 20. There is also considerable independent self-directed study in the instructional materials center by children who can read reasonably well and who have already acquired fundamental concepts.

IGE is more than an instructional program. There are seven major components of IGE:

1. An organizational-administrative structure, the multiunit organization, which is designed to provide for educational and instructional decision making at appropriate levels and open communication among students, teachers, and administrators. The organizational hierarchy consists of interrelated groups at three distinct levels of operation: the Instructional and Research (I&R) unit at the classroom level, the Instructional Improvement Committee (IIC) at the building level, and the System-Wide Policy Committee (SPC) at the system level. The multiunit organization is designed to provide for accountability and responsible participation in decision making by all the staff of a school system.
2. A model for developing measurement tools and evaluation procedures.

The model includes preassessment of children's initial skill development, assessment of progress and assessment of final achievement with criterion-referenced tests, feedback to the teacher and the child, and evaluation of IGE and its components. This model is used by Wisconsin R & D Center personnel in constructing criterion-referenced tests and observation schedules and by school personnel and others in implementing IGE.

3. Curriculum materials, related statements of instructional objectives, and criterion-referenced tests and observation schedules. These can be adopted or adapted by the staffs of individual school buildings to suit the characteristics of their students.
4. A program of home-school communications that reinforces the school's efforts by generating the interest and encouragement of parents and other adults whose attitudes influence pupil motivation and learning.
5. Facilitative environments in school buildings, school system central offices, state education agencies, and teacher training institutions. Helpful in producing these environments is a staff development program which includes inservice and campus-based educational programs to prepare personnel for the new roles implied by the other six components.
6. Continued research and development to generate knowledge and produce tested materials and procedures. In addition to the formal programmatic efforts of the Wisconsin R & D Center, each building must also engage in practical research in order to design, implement, and evaluate instructional programs for individual students.
7. A model of instructional programing for the individual student. This model, with related guidance procedures, is designed to provide for differences among students in their rates and styles of learning, levels of motivation, and other characteristics and also to take

all the educational objectives of the school into account. This model is outlined in Figure 1 and is used by the Wisconsin R & D Center personnel in developing curriculum materials and by school staff in implementing IGE [Klausmeier, 1971, pp. 17 & 18].

All seven of these major components of IGE have implications for the design of the computer-management system. However, the instructional programing model is especially important. The instructional components of the IGE program focus on the instructional programing model. This model implies a set of measurable objectives in a curriculum area as well as some defined linkages between these objectives. The instructional programing model is designed specifically to take into account the pupil's beginning level of performance, his rate of progress, his style of learning, his motivational level, and other characteristics in the context of the educational program of the building.

Step 1 of the model involves setting educational objectives for the children of the building.

Step 2 calls for identification by the staff of a subset of specific instructional objectives appropriate for a group of children. For example, only some of the 45 Word Attack objectives of the Wisconsin Design for Reading Skill Development (WDRSD) are suitable for children in the early stage of reading.

Step 3 is the actual assessment of each child's level of skill development, either by observing oral reading performances or by administering a group test. Criterion-referenced tests have been developed and validated for use in assessing mastery or nonmastery of the skills of the WDRSD. When the appropriate subset of objective-based tests is administered, the skill deficiencies of each child are pinpointed and instructional objectives for the individual child can be identified.

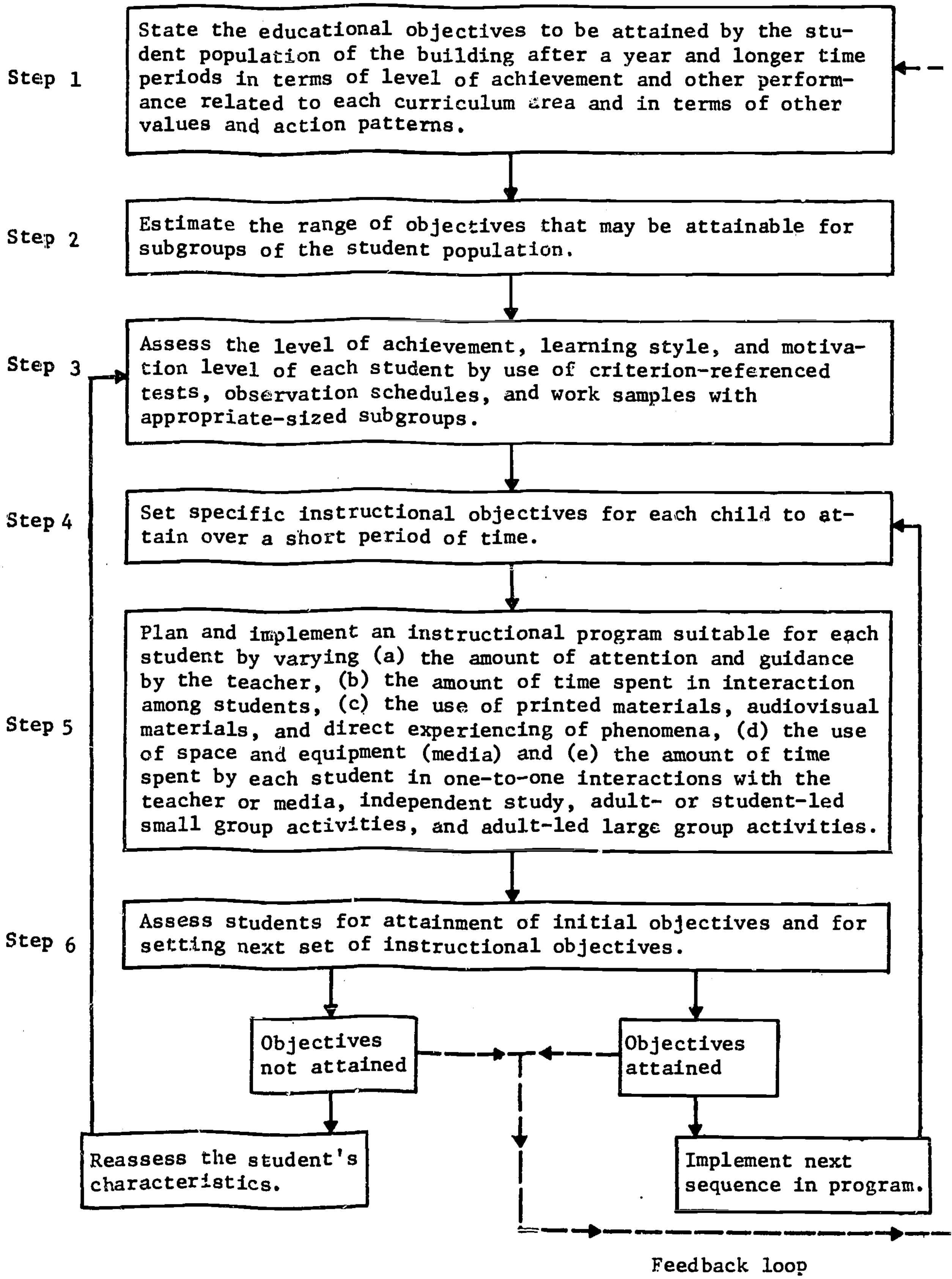


Figure 1. Instructional programing model in IGE.

Step 4 involves setting instructional objectives for each child in the unit. The behavioral objectives related to the skills in which the child is deficient become the child's instructional objectives. The child and the teacher discuss these objectives in an individual conference.

The first phase of step 5 involves planning an instructional program that will assist the child in attaining his objectives. The implementation of the planned instructional program marks the second part of step 5. Generally, each teacher instructs one or more groups of children who are working toward mastering the same skill. Further grouping may be done within each of these original groups. To the extent that staff is available, individual tutoring and goal-setting conferences are provided for children who profit from them.

After the instructional program has been carried out, an assessment is made to determine whether or not the specified objectives have been attained. If the objectives have been attained, new objectives are specified and the process is repeated. If the objectives have not been attained, a reassessment of the student's capabilities is made, a respecification of objectives takes place, and the remaining steps of the instructional programing model are repeated.

INDIVIDUALIZATION OF INSTRUCTION AND COMPUTER MANAGED INSTRUCTION

Individualization of instruction is not a new concept in the field of education; for many years there has been considerable interest in and support for individualized education (Whipple, 1925; Henry, 1962; Klausmeier et al., 1971). Though approaches, materials, and programs have varied, there has been a continuing focus on the individual student and his capabilities. Both commercial and private interests have entered the push to individualize education.

A common problem of all individualization programs has been the inability of teachers, clerical staff, and administrators to deal effectively with the great volumes of record keeping and processing necessary to individualize education. Since the development of digital computers in the early 1950's, there have been many attempts to bring these data processing capabilities to education (Johnson, 1971; Baker, 1971; Kaimann & Marker, 1967). The computer has been used effectively in education to assist in clerical and bookkeeping functions such as payroll, inventory, and student scheduling and grade reporting. More recently, the computer has been used to assist educational decision makers in collecting, summarizing, and reporting required information. Educational decisions have too often been made without proper background information, not because the information was unavailable, but because too much of the information was difficult to obtain and in unusable formats for decision makers. The computer processing capability can aggregate, sort, collate, and present large amounts of data in usable formats at appropriate times. This solution to the most crucial problem of individualized education has begun to be formally approached in several computer managed instruction projects.

COMPUTER MANAGED INSTRUCTION: A REVIEW

A system of computer managed instruction (CMI) has as its objectives collecting and processing information on students and supplying this information at appropriate times and places so that it is directly applicable to human decision making. When the appropriate information is supplied to decision makers in a usable format, the efficiency of decision making and the quality of decisions can rise. Cooley and Glaser (1968) stated, "The function of the computer in a CMI system focuses upon allowing better information flow to the complicated decision process on a continual basis." The teacher, student, and administrator continuously need information through which they can evaluate decision situations.

Bolton and Clark (1973) stated that the "concept and the function of CMI extend beyond traditional student accounting. This is a result of the growing mass of evidence which states that the true potential of management systems lies in allowing school systems to change their instruction procedures while maintaining the needed control [p. 5]." It is, then, the purpose of a CMI system to utilize the computer to optimize the learning environment for each child and to maximize the efficient use of school resources, both human and material. Constructed as a "man-machine system focused well beyond the limited scope of personnel and administrative systems, CMI combines the data-manipulation power of current hardware with the functional flexibility of instructional software to generate a demonstrably effective and efficient tool for the individualized school system [Bolton & Clark, 1973, p. 5]."

CMI is not to be confused with computer assisted instruction (CAI). CAI systems are designed to be a means of instruction in which the student is on-line to a computer through an interactive terminal. In such systems, information and/or stimulus material is presented to the student, student responses are accepted and processed, feedback is provided to the student, and the computer maintains various degrees of control over the sequencing of material. Specific categories of such interactive instruction include tutoring, drill and practice, case study, gaming, and laboratory simulation. Unlike commonly known CAI systems, machine/student interface is generally not a part of a CMI system. Since the drill and practice aspects of CAI can be both valuable to student activity needs and a source of computer input, CAI can be considered as a subset of a complete CMI system (Bolton & Clark, 1973). The objectives of CMI are collecting and processing performance information for each student and making this available to school personnel in order to assist them in making appropriate instructional decisions.

In contrast with CAI, where the computer program, through direct participation with the student, "would present instructional materials to the student, collect his responses, analyze them, and select the next step to be performed by the student [Baker, 1971, p. 51]," CMI is a system through which the computer and the instructional team--teachers, principals, district administrators--cooperate to administer and guide the instructional process. The computer, then, is less a teaching machine than an information system.

One striking difference between CMI and CAI is the number of interactive terminals required in the schools. Since CAI involves a one-to-one relationship between a student and a terminal, implementation of CAI requires a number of terminals in a school. CMI systems do not necessarily have to be on-line. Input data and reports can be carried by messenger between the school and the computer facility. When CMI systems are on-line, one terminal per school is generally sufficient.

Many research groups across the country conceptualized CMI systems almost concurrently. In a recent survey (Baker, 1971), the characteristics of these systems were examined and a great deal of similarity was noted among them. This survey showed that, generally, each of the various CMI systems is built around units of instruction that are specified in terms of educational objectives, desired student behavior, levels of competence, and/or concepts to be learned. Associated with each instructional unit are criterion-referenced tests for each objective in that unit which assess level of mastery. Typically, such tests are administered as pretests to determine a student's present level of achievement and as posttests to determine if specific objectives have been achieved.

> These studies differ in a variety of ways such as reliance on off-the-shelf materials as opposed to developing new instructional resources. They also address different academic levels and areas. Their similarities are greater than their differences, however. All are designing learning interventions based on carefully specified behavioral objectives and all are using the computer to mediate between the student, his individual performance on the objectives, and the inventory of instructional resources related to the objectives [Morgan, 1969, pp. 2 & 3].

In each of the systems, four major functions are performed by computers: test scoring, diagnosing, prescribing, and reporting (Baker, 1971). Typically, a pretest, which is computer scored, is taken by each pupil at the beginning of each unit of instruction to determine his status relative to instructional objectives. On the basis of the pretest results, the pupil is assigned specific learning tasks. The prescribed tasks can be of a number of educational experiences, but in most instances, a student engages by himself in an educational experience such as seat work, reading books, CAI or working with some audio-visual material. At various points within a unit, the pupil may take diagnostic or progress tests which are also computer scored and which assess his progress toward specific objectives contained within the unit. Reports are generated based on the test results which indicate whether the student is meeting the objectives assigned to him. When the pupil has completed the assigned tasks, he takes a criterion-referenced posttest. If the student does not demonstrate mastery of certain educational objectives, he is assigned alternate work. After a unit has been completed, the basic pattern of pretest, diagnosis, prescription, and posttest is repeated for each unit of instruction. In some systems, a posttest may serve as a pretest for a subsequent unit. Within these general characteristics, the several various ongoing CMI projects differ only in detail or emphasis upon the prescriptive aspects of the system. Rudimentary prescriptive procedures are part of most CMI systems, but the amount of detail in the prescription varies (Baker, 1971). In some systems (TIPS and IPI/MIS, described later in this chapter) the test score obtained by the student is translated by the computer program into a folder number, text chapter, or lesson. Other systems (CMS, PLAN, IMS, and AIMS, described later in this chapter) use tests as grouping mechanisms from which the teacher can make prescriptive decisions.

Allen Kelley--TIPS

The concepts underlying CMI were independently derived by Professor A. C. Kelley (1968) in the context of an introductory economics course at the University of Wisconsin. Although the Teaching Information Processing System (TIPS) was developed in isolation, it follows the general model very closely and contains all the basic features of other systems. The TIPS project was embedded within a conventional university level economics course in which a professor presented the lectures and teaching assistants conducted small-group sessions (Baker, 1971). In sharp contrast to other systems, the prescriptions generated by TIPS are in the form of paragraphs rather than in the usual cryptic lesson numbers and state what the student is to do, whether it is optional or required, and the date it is due. The prescriptions ranged from the usual homework assignment to attendance at lectures given by instructors in other economics courses. In some cases, the student was referred to the teaching assistant for help in a small-group setting (Baker, 1971). Three different reports were generated: the student report, the teaching assistant report, and the professor report. Kelley indicated that these reports were available within a few hours after the students responded to the questionnaire; this response time was much better than that typically achieved. Kelley's TIPS is based on the same basic model as those systems developed by educational researchers. The mechanisms of the TIPS approach are such that they could be applied easily to other college-level courses.

Pittsburgh Research and Development Center--IPI/MIS

Another CMI system, in operation through the Pittsburgh Learning Research and Development Center in the Baldwin/Whitehall School district, is an outgrowth of the Individually Prescribed Instruction (IPI) project and is called the IPI/Management and Information System, or IPI/MIS (Cooley & Glaser, 1968). The developers first individualized the elementary school curriculum with a manual system of test scoring, diagnosing results, prescribing instructional tasks, and record keeping and later automated these tasks. The computer configuration used consisted of a medium-sized computer, a large desk storage device, a remote batch input/output station in the school, and three typewriter-style remote inquiry stations in the Learning Research and Development Center. According to Baker's (1971) review, the remote input/output station in the school is used to print three basic types of reports. First, a unit summary for a particular student is produced that contains test scores for the pretest and curriculum embedded tests corresponding to a given instructional unit. The prescription suggested by the computer after each testing is also listed. The teacher uses this report to trace the activities of a pupil within a unit and to ascertain how well he performed on the unit. Second, a pupil listing by home room is generated that shows for each pupil the skill, the unit of instruction, and the number of days spent on the unit. Third, an instructional report is produced that lists the names of the pupils who are working on a unit and the specific objectives they are currently attempting to master. Again, this report is useful for informing the teacher of the status of the pupils, each of whom may be engaged in a different task. A unique feature of IPI/MIS is the prior existence of an elementary-school curriculum designed for individualized rates of progress. As a result, the IPI/MIS approach is an excellent base from which to develop and implement the instructional decision-making processes that are the stated long-term interests of Cooley and Glaser (Baker, 1971).

University of Wisconsin--CMS

The Individualized Mathematics Curriculum Project (IMCP), developed in 1964 (DeVault, Kriewall, Buchanan, & Quilling, 1969), was aimed at teaching children how to plan their own learning objectives in mathematics and how to become increasingly responsible for the organization of the available human and material resources necessary to attain these objectives. The school in which the IMCP was conducted had a physical plant especially designed for team teaching as well as many features which facilitated the development of an individualized curriculum (Baker, 1971). The program relied on a computer-based inquiry system called the Computer Managed System (CMS). The University of Wisconsin computer was used to implement the system, and a teletype terminal was placed in the school. Test data were machine scored, and the results were entered into the data base through the teletype. The teachers used a series of simple inquiry statements to obtain from the data base information such as scores on unit tests, lists of units completed by each pupil, and the hierarchy of the units within the strand-level unit structure. The teacher could request data by pupil name or by groups of pupils with specified characteristics. The inquiry system was designed to facilitate the placement of pupils in instructional groups on the basis of what units they have completed within each strand (DeVault et al., 1969).

The CMS project differs from other computer-based management systems in the areas of diagnosis and prescription. Its diagnostic capabilities are limited to listing pupils according to the units they have mastered or attempted. CMS does not generate specific prescriptions but simply lists all of the units for which a pupil has completed the prerequisites. The actual prescription is left up to the teacher and the pupil; the pupil has considerable responsibility for making instructionally related decisions (Baker, 1971).

University of Wisconsin--MICA

A second CMI system developed at the University of Wisconsin-Madison is Managed Instruction with Computer Assistance (MICA) (Behr, Berg, Jacobs, LaFaivre, Relles, & Underwood, 1972). This system was developed by Dr. Frank B. Baker and implemented at the Sherman School in Madison, Wisconsin. This system, too, is a response to the overpowering volume of clerical and instructional work necessary to the individualization of education. While teachers are involved in procedures of evaluation, diagnosis, and prescription, they are unavailable for instruction, student problems, and handling of specialized instructional materials. MICA is designed to provide the teacher with evaluative and diagnostic information. Through terminals connected with the computer, the teacher has immediate access to a wide range of information upon which prescriptions can be based. Within the MICA system, the teacher is presented a list of possible prescriptions given the instructional situation. This list of alternatives frees the teacher to select an educational approach and assist in its implementation. The immediate computer access and lists of alternative prescriptions are the unique features and strengths of the MICA system.

American Institute for Research--Project PLAN

The project Program for Learning in Accordance with Needs (PLAN) was developed by the American Institute for Research and Westinghouse Learning Corporation. Although the actual implementation of PLAN follows that of other CMI systems, emphasis is placed upon long-term educational goals as they relate to career planning and educationally relevant decision making. Conceptually, PLAN consists of five components (Flanagan, 1969):

1. A comprehensive set of educational objectives which are successively fractioned until the smallest subdivision of the objective requires about two hours of student study time. Approximately five of these smaller objectives are grouped into a module, and the modules are pooled to form an instructional unit of about two weeks duration.

2. Teaching-learning units relating to each objective which provide alternative means for the pupil to use in achieving the objective. (At the present time, these units consist of available conventional instructional materials and procedures.)

3. Evaluation procedures involving the use of criterion-referenced tests related to the objectives within the units and to the long-term educational goals. Certain goals are measured via instruments other than multiple-choice tests.

4. Guidance and individual planning procedures designed to aid the pupils in planning their educational development. Of

particular interest is a career planning game, employing project TALENT data, that gives the pupil experience in career planning and in making relevant educational decisions.

5. A medium-sized computer with input/output terminals in the participating schools. The stated function of the computer is to perform clerical and statistical activities of a teacher-support nature.

Most accounts of project PLAN discuss only its concept, not the actual implementation. Further, the computer is mentioned only in a minor role. For example, Flanagan (1967) stated, "The computer will be an inconspicuous and incidental part of the program as far as the teacher and student are concerned. Neither of them may ever see the input/output terminal in the school building or the computer itself."

Systems Development Corporation--IMS

The computer-based instructional management system developed by the staff of the Systems Development Corporation (SDC) was the Instructional Management System, or IMS (Silberman, 1968). The system was implemented initially in several first-grade classrooms with reading as the subject of interest. Each class was divided by its teacher into several reading groups. After a day of instruction and testing, the answer sheets were taken by courier to the SDC computer facility where they were optically scanned and the item response choices were punched into cards. The cards served as input to a large computer that scored the tests and generated the appropriate reports. These reports were available to the teacher before class the next morning for use in planning.

The data resulting from a test taken by a reading group were presented to the teacher in several different reports. The basic report was for the particular test taken and contained information concerning the specific objectives covered in the test. Summary reports were issued weekly, and special reports could be requested as appropriate. A teletype terminal was available in the school for such requests for data. The flexibility of the underlying data management computer program allowed the researchers at SDC to easily redesign the reports or to delete or add information as new needs arose (Bratten, 1968).

The IMS development is a very pragmatic approach to implementing a computer-based instructional management system within a conventional classroom setting (Baker, 1971).

Advanced Systems Laboratory --AIMS

A CMI system developed by the Advanced Systems Laboratory of the New York Institute of Technology is AIMS, the Automated Instructional Management System (Fritz and Levy, 1972). Helen Lekan states that AIMS is

> a system for directing a student or a group of students through any course designed around behavioral objectives. Outputs are reports giving the performance information that is directly relevant to the role of the student or instructor or course designer or any combination of these. The system is specifically designed to be independent of the course or curriculum, subject area or level so that it can be utilized with any course material designed around behavioral objectives [Lekan, 1971, p. 151].

AIMS was designed to collect data, thus providing the teacher with a highly competent assistant for making routine instructional decisions. These are tasks which a teacher can do well for a few pupils but inadequately for a large number. The teacher would monitor pupil performance, ascertain short- and long-term trends, use this information to understand a given pupil as an individual, and supplement this data with uniquely human traits such as understanding, motivation, etc., which are vital but intangible in the educational process. The teacher can then develop the management techniques and clinical judgment underlying the successful operation of an individualized program of instruction. The teacher would use the computer as a vehicle for obtaining timely, accurate, and relevant information needed to fulfill the role of an educational manager (Fritz & Levy, 1972).

INDICOM and DRIFT

The INDICOM Project is a developmental program at the Waterford Township School District in Pontiac, Michigan. It employs CMI in the business education curriculum. DRIFT is a CMI system being used in the Multnomah County Intermediate Education District of Portland, Oregon. A diagnostic test of 85 questions is administered as a pretest (and posttest) to children in the sixth-grade mathematics program. A comprehensive analysis of wrong response patterns causes the selection of significant diagnostic statements from 200 available statements. The program has been successfully used for grades 5-9. Prescriptive statements are being added (Fritz & Levy, 1972).

Summary

It can be seen from the descriptions in this section of some of the leading CMI projects that although they differ in several aspects (level, state of implementation, focus, and breadth of attack), they all seem to manifest and provide information useful in instructional decision making. All systems, further, are based upon a framework of objectives from individual student behavioral objectives through system-wide goals. These objectives are the framework for the decision foundation of a CMI system.

These CMI systems emphasize four basic processes: testing, diagnosing, prescribing, and reporting. Information is collected from student groups through criterion-referenced testing and analyzed relative to specified levels of mastery, prescriptions are formulated, and results are reported. This information is then utilized by classroom level decision makers (students and/or teachers) in selecting subsequent instructional activities. Usually, summary reports of student achievement are also produced periodically for use in monitoring class progress.

A MODEL FOR A COMPUTER-BASED SYSTEM FOR INSTRUCTIONAL MANAGEMENT (WIS-SIM)

Objectives of WIS-SIM

The primary function of the Wisconsin System for Instructional Management (WIS-SIM) is to improve decision making relative to the instructional program of the school, thus leading to maximized educational benefits for each child while making efficient use of available human, material, and financial resources.

WIS-SIM has the following specific objectives: (1) to identify decisions which are related to the instructional process, (2) to determine what information would be most useful to decision makers involved with the decision, (3) to arrange mechanisms to capture required data, (4) to summarize the data in a form most usable to the decision maker, (5) to arrange for the timely delivery of appropriate information to the decision maker, and (6) to evaluate the utility of the information to the decision making process.

Thus, in order to establish optimum learning environments and maximize use of school resources, it is necessary to make appropriate and timely information available to the decision makers. The teachers in the I & R unit are the decision makers who have the greatest and most frequent need for information, for the ultimate responsibility for planning and implementing an instructional program suitable for each student is theirs. The student himself is a significant decision maker since he may be involved with his teacher in establishing specific instructional objectives for himself; thus, he must have feedback as to his progress toward attainment of initial and long-term goals. And for young children, it is important that feedback of progress be fairly immediate in order to yield maximum motivational value. The parent, due to his key role in influencing pupil motivation and learning, must also be involved in establishing instructional objectives and monitoring their attainment.

Two major decision areas are specified by the instructional programing model of IGE. The first decision type involves establishing educational objectives at the various organizational levels: the district (SPC), school (IIC), unit (I & R), and the individual student. These are long-range objectives within a curriculum area and are clearly highly dependent upon one another. District-wide goals need to be broken down into school, unit, and individual goals. Individual goals, when aggregated, represent unit, school, and district level objectives.

Once long-range goals are decided upon, it is necessary to translate these goals into the context of the individual student. The second major decision area specified by the instructional programing model is the selection of appropriate educational experiences for each child. This decision area requires that educational objectives be made specific to the individual child and that educational experiences be prescribed which are designed to meet these needs within the constraints of efficient utilization of available resources.

WIS-SIM Model

As indicated in the specific objectives given above, WIS-SIM was conceptualized to provide appropriate and timely information to decision makers. WIS-SIM focuses on decision making in the areas of specifying performance expectations (establishing educational objectives) and selecting appropriate educational experiences.

Several assumptions are made relative to consideration of WIS-SIM. It is assumed that within a given curriculum area:

1. A specified set of measurable objectives exists.

2. Instrumentation exists which is capable of assessing achievement of the specified objectives.

3. Level(s) of mastery have been established for each of the specified objectives.

4. Dependencies existing between objectives are specified.

5. It is possible quantitatively and/or qualitatively to assess the individual characteristics of students essential to individualizing instructional prescriptions.

6. Alternate educational experiences exist leading to the accomplishment of the specified instructional objectives.

7. It is possible quantitatively and/or qualitatively to assess the resource implications of alternate educational experiences.

8. Normative information exists, as desired, for input into the decision of specifying long-range performance expectations.

Each of these eight assumptions is important in providing information required as input to WIS-SIM.

The general model of WIS-SIM is depicted in Figure 2. The two major decision areas--specifying performance expectations and selecting appropriate educational experiences--are depicted as diamonds in Figure 2. Five major processes, in addition to the two decision processes, are viewed as being central to the man-machine CMI system: test scoring, achievement profiling, diagnosing, prescribing, and instructing. These processes form a loop, indicating their cyclic nature in the system.

Test Scoring and Generating the Data Base

The data base utilized in subsequent WIS-SIM processes contains two types of information--curriculum objectives and assessments of student

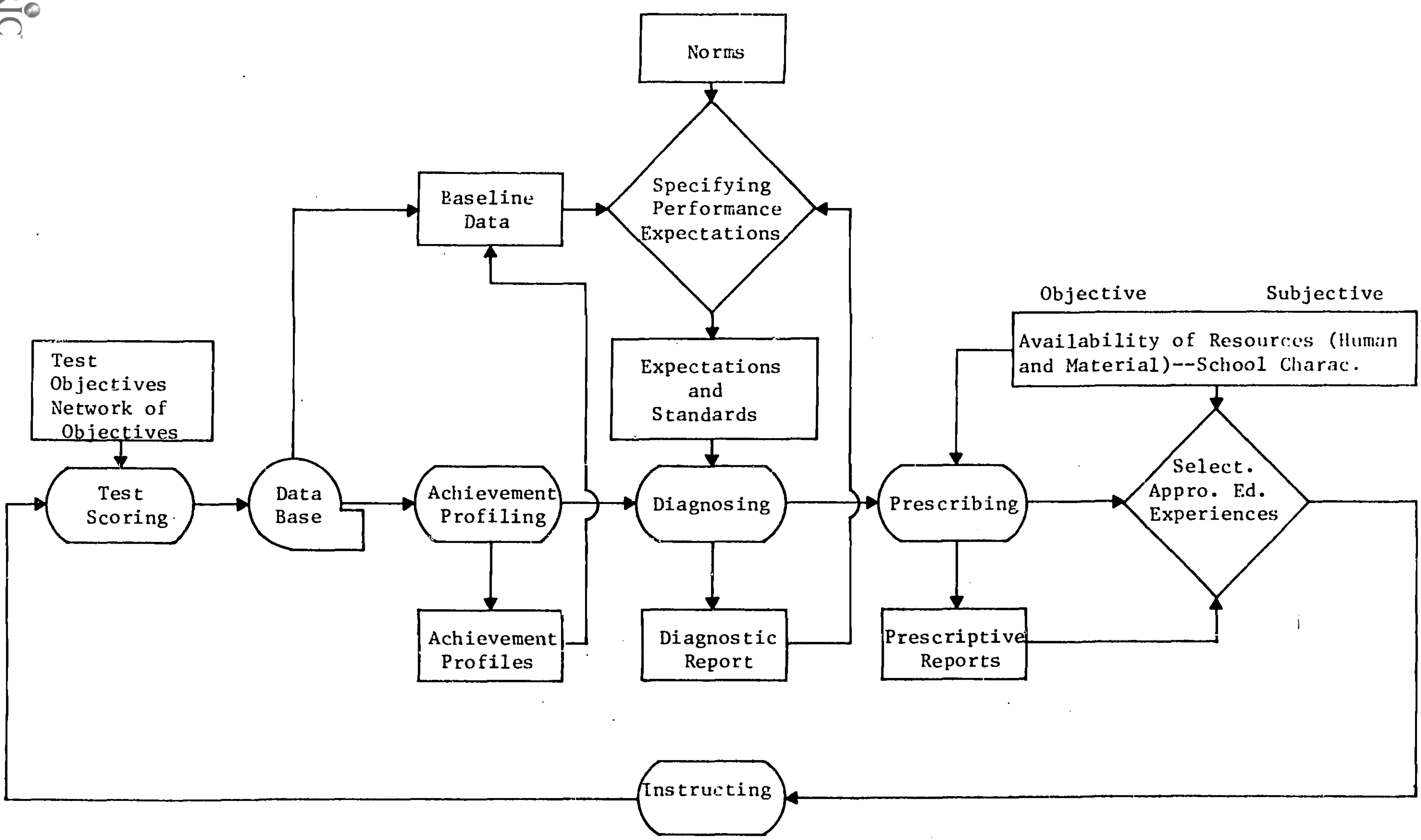


Figure 2. Model of system for instructional management.

achievement. The instructional program specified in the assumptions requires measurable objectives, criterion-referenced tests, mastery levels to be attained, and identification of the interdependency of objectives (prerequisites) within the program. The data base within the CMI system requires that objectives be identified with prerequisites and criterion levels. In order to initialize the data base relative to student achievement, a preassessment generally takes place. The achievement level of each student relative to the objectives specified in the curriculum may be derived. As instructional experiences take place, periodic assessments are made and the student achievement portion of the data base is updated. Data base elements within the two major components are summarized as follows:

Curriculum Objectives	Assessments of Student Achievement
Objectives	Objective
Dependency between objectives (prerequisites)	Score on mastery test
Mastery levels to be achieved	Date of testing

Test scoring and subsequent data base generation and updating are fundamental CMI processes. Each may be a man function, a machine function, or a combined man-machine function within the system. Machine-dependent test scoring is not always the most effective mechanism. In many cases, expense of equipment, short test lengths, or time requirements relative to machine availability will require manual scoring of tests. Additionally, some assessments may be recorded in forms which are not amenable to machine scoring. When machine scoring meets the decision-making requirements in terms of speed, convenience, and cost, it is clearly desirable to utilize this approach. In either event, tests are scored and the results are recorded in the data base.

Achievement Profiling

Achievement profiling produces a report summarizing the progress of an individual student across all instructional objectives in the curriculum area or summarizing the performance of a group of students across a group of objectives. This report shows the placement in the instructional program of students at the time of the report. These reports may be used in the same way that traditional grade reports are used--as feedback to parents and students and as input to parent-teacher-student conferences and goal setting. Achievement profiles may also be produced at the school and district levels; these profiles may be summaries by unit of the number of studen reaching mastery on each objective. It should be noted that achievement profiles summarize achievement of the pre-specified mastery levels for the individual students.

Diagnosing

The function of diagnosis within WIS-SIM is to compare achievement information, defined as level(s) of mastery, with pre-established performance expectations. A low level of diagnosis identifies those objectives which the student has mastered and identifies those objectives which the student has not mastered. Such reports, if produced, would be diagnostic in the sense that they identify student needs. The performance expectations in this case are the prespecified mastery levels entered into the data base. This type of diagnostic report differs little from achievement profiles.

A portion of Figure 2 is reproduced as Figure 3 and shows the relationship between the decision of specifying performance expectations and the process of diagnosis. The decision of specifying performance expectations

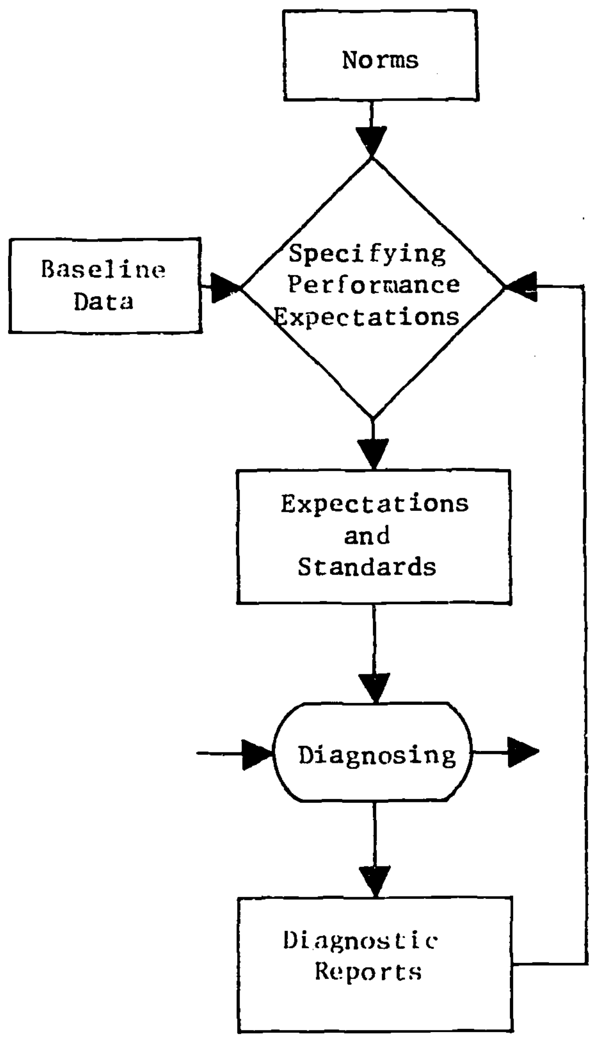


Figure 3. Role of performance expectations in diagnosis.

establishes long-range goals for individuals or groups participating in an instructional program. These goals relate to the accomplishment of several of the individual objectives which are a part of the curriculum area. Expectations may be established for individual students on the basis of information such as past performance in the instructional area, existing norms, information from teacher-student-parent conferences, and other available information the decision makers in the I & R unit deem appropriate. It is also possible to establish at this point such standards of performance as minimal or maximal levels of progress to be accomplished within fixed periods of time by all students within a group. Not that these will interfere with the individualized program of studies; they will serve as signals for special programatic consideration. Research may suggest certain dysfunctional patterns of mastery-nonmastery within the network of objectives which are associated with difficulty in future areas of instruction. The absence of these patterns may serve as standards for comparison.

Specific expectations and standards result from the decision of specifying performance expectations. These expectations serve as input to the diagnostic process. Diagnosis, then, is the process of comparing the individual student's achievement record, in terms of level(s) of mastery across objectives, with the expectations and standards established for that student. Reports may be developed which present the results of these comparisons for each student to decision makers, but more important and more useful are reports which indicate those students whose achievement levels are greatly out of tolerance with respect to the expectations and/or standards. These exception reports flag the students who may need extra consideration in instructional programing through one-to-one instruction or the use of supportive personnel such as speech therapists or social workers. Diagnosis in reports also could be used to identify students who are moving rapidly through the objectives for use in tutoring situations with other students.

Feedback from the diagnostic report to the decision level is depicted in Figure 3 to indicate the possibility of revising expectations. It is possible that the presence of a student in an exception diagnosis report indicates an inappropriate expectation or standard rather than a deviation from an appropriately specified standard. Resulting from the diagnostic process is an explicit or implicit assessment of the instructional needs of the student. This information is input to the prescribing process.

A diagnostic function can also take place at organizational levels other than the I & R unit. If long-range goals are specified, actual achievement of students can be summarized as indicated in the section on achievement profiling. These summary scores by unit and/or school can be compared with the expectations set for those levels by the SPC or the IIC. The diagnostic reports generated from this analysis might lead to revisions of the expectation or of instructional activities or programs.

Prescribing

The need for CMI systems is based on their ability to assist in the effective implementation of programs for individualizing instruction. Although diagnosis and achievement profiling take place on an individual level, nothing presented thus far in the discussion of WIS-SIM has provided for an individualized instructional program. It is the prescribing function, the associated decision of selecting appropriate educational experiences, and the subsequent instructing function which individualize the educational program.

The prescribing function of CMI systems utilizes the input which results from the diagnostic function and formulates a prescription or alternative prescriptions which are deemed appropriate to meet the needs identified by the diagnosis. The objectives which have not yet been mastered by the student are searched relative to prerequisites which may exist, and prescriptions result which are considered "best" according to programed criteria. In many systems, the teacher reviews the prescription and makes the final decision as to the best instruction prescription.

Individualization of instruction takes place in a variety of forms. Some programs allow students to proceed independently at their own pace through the instructional objectives of the program. Upon completion of an objective or an objective set, testing and diagnosis take place and a new instructional activity, directed toward the next objective, is prescribed. Many programs which allow this type of individualization are linear in nature; that is, instructional objectives may be ordered from 1 to N, and as the student masters objective 1, he begins objective 2, and so on. Other programs present alternative instructional activities and allow for students and/or teachers to make the final selection as to what next activity should be implemented. Many of these systems generate prescriptions which refer the student to programed materials, work books, file folders, texts, or possibly the teacher.

IGE specifies that an instructional program should be planned and implemented for each student which varies (1) the amount of attention and guidance by the teacher, (2) the amount of time spent in interaction among students, (3) the use of printed materials, (4) the use of space and equipment (media), and (5) the amount of time spent by each student individually with the teacher or media, in independent study, in adult- or student-led small-group activities, and in adult-led large-group activities. This view of instructional individualization is a clear departure from the "file folder" approach. Prescribing within the context of IGE, then, involves not only the notion of independent study, but also the notion of grouping students with common needs together in instructional settings.

The selection of appropriate educational experiences is a complex decision involving such parameters as student need, learning style, and motivation, teacher availability, alternative instructional activities for the objective, and presence of other students with the same need. Student need can be established as a result of diagnosis. The other parameters, at this point, are largely subjective. It is an ongoing goal of WIS-SIM to develop machine-formulated prescriptions which take as many of these factors as possible into consideration. The objective is to select educational experiences for the student which maximize educational benefit while considering the availability of human, material, and financial resources.

Reports resulting from the prescriptive function are used by unit level decision makers in selecting educational experiences for students. These reports focus on the grouping function by presenting listings of students who are eligible in terms of need and prerequisites for a particular objective. Other information, such as previous attempts at the same objective, may also be noted.

Instructing

The prescription and following selection of an appropriate educational experience is implemented during the instructing process. While this process tends to be largely a man function rather than a man-machine function in the system, CAI, a component of CMI, could be utilized to automate a portion of this process. If CAI is used, assessment may be imbedded in the instruction process; thus, the instruction and testing functions may merge. In this arrangement, following the prescribed instructional activities, testing takes place and the cycle is repeated.

Other Functions of WIS-SIM

While the major thrust of CMI systems is directed at providing information to decision makers at the unit level, it has been noted that reports may be generated for use by decision makers at the IIC and SPC levels. These reports are used in making decisions related to the effective implementation of the instructional program at the school or district level.

The information stored in the CMI data base is a detailed historical account of student achievement in the included instructional areas. This information, along with other personal, demographic, and standardized test data, provides a valuable resource in the study of cognitive learning. The results of such research should be useful in improving diagnosis and prescription within CMI systems.

SUMMARY

A CMI system, WIS-SIM, has been derived from the instructional programing model of IGE. This system focuses on two major instructional decision areas--specifying performance expectations and selecting appropriate educational experiences. To provide information to those making these decisions, five processes and their resulting reports have been discussed. These processes are testing, achievement profiling, diagnosing, prescribing, and instructing. Additional applications that would utilize the WIS-SIM data base for district level decision making and research purposes have been suggested.

Chapters II and III of this study discuss the utility of the WIS-SIM model in meeting the instructional management requirements of the Wisconsin R & D Center's reading (WDRSD) and mathematics (DMP) programs. Chapter IV of this report considers development and design strategies.

II

COMPUTER MANAGED INSTRUCTION AND THE WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

The Wisconsin Design for Reading Skill Development (WDRSD) conforms to the concepts of IGE as described by Klausmeier et al. (1971) The focus of the WDRSD involves four fundamental purposes. These are (1) to identify and describe behaviorally the skills which appear to be essential for competence in reading, (2) to assess individual pupils' skills development status, (3) to manage instruction of children with different skill development needs, and (4) to monitor each pupil's progress (Otto & Askov, 1972).

This chapter attempts to show how these purposes are being pursued within the framework of the WIS-SIM system of CMI. Although the pilot test of computer management of the WDRSD will take place during the 1974-1975 school year, the requirements the program imposes for computer management have been fairly well defined as a result of a joint design effort which is currently being carried out by the Wisconsin R & D Center and the Duluth School System (Belt & Giroux, 1974). This chapter describes the nature, utilization, and flow of information which resulted from an analysis of the requirements of WDRSD, IGE, and Individually Guided Motivation (IGM). IGM will be discussed in Chapter IV.

The information flow discussion in this chapter is organized in terms of the decision areas associated with the WIS-SIM model presented in Chapter I. One major decision is related to providing the maximum educational benefit for each student while considering the use of available school resources--human, material, and financial. In practical terms, the major decision is to select from available instructional experiences the one that appears to be most appropriate at a specific time for each child. In IGE, the available instructional experiences cover a broad spectrum including independent study, teacher-student counseling sessions, tutoring sessions, activities for small to medium-sized groups, and large-group sessions. The most frequently utilized instructional experience in IGE is the small to medium-sized activity group of from 8 to 20 children who have common educational needs. An activity group of this size appears to be an effective and efficient instructional setting. The interaction which takes place in such settings can be highly motivational and can produce positive social outcomes. Teachers are assigned to activity groups on the basis of their expertise and interest in teaching that activity. The placing of children into appropriate instructional groups is based on relevant diagnostic and prescriptive information. The prescription integrates individual student diagnosis, sequencing and clustering characteristics of the curriculum, and the availability of school resources (space, materials, teachers with special skills, and interest for conducting particular activities).

A second major decision area involves the specification of performance expectations for each child. Diagnosis, then, is based on the comparison of individual achievement profiles to normative data or to their established performance expectations. The specification and monitoring of goals at the unit, building, and system levels enable implementation of a quality control function. The information flow description in this chapter will conclude with a description of data base considerations including data base initiation and maintenance.

THE WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

The implementation of IGE through the use of the WDRSD involves assessing each child's skill development, grouping children who need to develop the same skill or configuration of skills, providing individual assistance as necessary within each group to take into account differences in rate and style of learning, providing for independent activity or study, reassessing, and regrouping as some children develop the configuration of skills, or part of them, and others do not.

Prominent in this approach is the realization that the guidance of the education of each child by a teacher is required. Many children, perhaps most, will not learn to read with a high degree of independence and enjoyment except as guided by able teachers.

In developing curricular components, the Wisconsin R & D Center establishes broad educational goals for each curriculum area. In WDRSD, the goals are developing proficiency in the areas of Word Attack, Study Skills, and Comprehension and providing appropriate experience in the areas of Self-Directed Reading, Interpretive Reading, and Creative Reading. For each of the three proficiency areas, observable behavioral objectives have been defined whose mastery constitutes proficiency in these areas. Once these behavioral objectives have been defined, it is necessary to determine their appropriate sequencing. Initially, such sequencing is based upon expert opinion. When the program is field tested, such sequencing is confirmed or established empirically. Behavioral objectives at the introductory level of Word Attack include such things as listening for rhyming elements, noticing likenesses and differences in shapes, and listening for initial consonant sounds. Behavioral objectives at the check-out level of Word Attack include a sight word vocabulary, phonic analysis skills, and structural analysis skills.

For each behavioral objective, instructional materials, activities, and teaching techniques must be selected or developed. Central to the instructional management function is the development of pupil assessment instruments for each behavioral objective. These measurement instruments are known as criterion-referenced tests since the purpose of the tests is to measure a desired student behavior or level of competence in relation to the objective. This is in contrast to norm-referenced testing which permits evaluation of a student's performance in relation to other students. Thus, the definition of educationally significant goals; the identification of requisite, appropriately sequenced behavioral objectives; and the development or identification of related instructional materials, teaching techniques, and criterion-referenced tests permit students to proceed individually and continuously toward the attainment of important educational goals.

SELECTING APPROPRIATE EDUCATIONAL EXPERIENCES

The establishment of large-group teaching sessions requires little formal input of specific diagnostic and prescriptive information. Such teaching sessions are set up to provide broadly based orientation and introductory experiences as well as to satisfy critical logistic requirements. Such logistic requirements include making a guest lecturer or guest resource person available to a large number of students or making a one-time film or broadcast similarly available. The establishment of small to medium-sized activity groups does, however, require updated diagnostic information for individual children as well as the integration of curriculum sequencing information and information regarding the availability of specific teachers, space, and materials.

When teachers are about to become available, a skill grouping request is submitted to the computer on which are listed the specific skills for which the available teachers have particular expertise and interest. In selecting specific skills to be taught next, due consideration is also given to availability of related materials.

In each grouping period, at least 90 percent of the students should be placed in groups (Otto & Askov, 1972). Figure 4 illustrates a specific grouping report. This report may be used for establishing instructional groups within units of multiunit schools, within self-contained classrooms, or within an entire school building. The report is based upon prerequisite skill mastery, and it also indicates whether a student has previously taken the criterion-referenced test for the selected skill and has failed to achieve mastery. The number of such attempts is listed along with the date and score of the last attempt. The request for a specific grouping report can be made via a teleprinter keyboard in the case of an on-line system. In batch systems, a phone call can be made to the computer facility or a form can be sent.

The establishment of small to medium-sized skill groups which will meet from two to three weeks is a major management function since each such grouping accounts for a sizable number of student and teacher instructional hours. It is possible to add a child to ongoing skill groups or to establish ad hoc educational experiences. Student diagnostic data to be used in forming skill groups is available. A major source of such diagnostic data is the unit (or class) performance profile report (see Figure 5). This report permits the teacher to keep abreast of each student's achievement profile and to rapidly determine the relative achievement status of each student in his unit (or class). The report is updated weekly; it serves as a basis for conducting parent conferences and student-teacher conferences and for identifying students who would benefit from independent study or tutoring sessions in particular skill areas.

The report format is engineered to highlight essential data. Thus, when a student has mastered all skills at a given level, scores on those skills are not reproduced. An indication is given that mastery of all skills at

SCHOOL: UNION
UNIT:

SPECIFIC GROUPING REPORT

AS OF 11/13/73

WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

GROUPING FOR SKILL B5 - WORD ATTACK SKILLS

PREREQUISITE MASTERY - ALL A SKILLS AND B3 AND B4

STUDENT NO.	STUDENT NAME	GRADE	ATTEMPTS	DATE OF LAST ATTEMPT	LAST %
0375	JAMES CALDER	01			
0685	OMER DOYLE	01			
0980	JOHN SCOTT	01	1	09-23-73	65
1030	RUTH CHASE	01			
1135	RORY JAMES	01			
1175	RICHARD NOLEN	01	1	10-09-73	75
1350	JERRY LYNCH	01			
1515	BOBBY TRANE	01			
1605	ROBERT DOTT	01	1	09-02-73	75
0030	DAVID TRICE	02	1	09-16-73	60
0090	ALICE MOLZAHN	02	1	09-23-73	60
0230	MARGARET SMITH	02	1	09-23-73	60
0360	JESSICA CURTIS	02			
1740	JOYCE ALLEMAND	02	1	09-16-73	75
0795	LISA KRUGER	02	1	09-02-73	40
1040	JANE RAHN	02			
1125	ART BRAGUE	02	1	09-09-73	25
0747	PATRICIA SUELLEN	03			

Figure 4. Specific grouping report.

HOOL: DAVIDSON ELEMENTARY
..IT: M

UNIT PERFORMANCE PROFILE

AS OF 2/10/73

WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

WORD ATTACK SKILLS

NUMBER	NAME	A1	A2	A3	A4	A5	A6	ALL A MASTERY	B1	B2	B3>	B4>	B5	B6	B7	B5 → B8	B9	B10	B11>	B12>	B13	ALL B MASTERY
0035	ABBOTT, WILLIAM A.							M	M	M	M	M	M	M	60	M	53	20	M	M	M	
0075	ALDER, PATRICIA A.							M	M	NM	M	M	M	M	53	M	53	20	67	50	15	
0130	ALEXANDER, JOHN T.							M														M
0190	BARNES, PATRICIA L.							M														M
0205	BILLINGSLEY, LAURA A.							M														M
0320	DEBOER, ROGER							M	M	NM	M	60	M	M	40	35	35	33	M	M	35	
0335	DELANEY, JANET R.							M														M
0340	FRANKEL, STEVEN							M	NM	NM	M	M	M	35	40	M	53	40	33	M	35	
0415	FRUSHER, KITTY							M	M	M	M	M	M	40	M	M	M	M	M	M	M	
0420	FULLER, TIMOTHY K.							M														M
0535	GEMPELER, THOMAS Q.							M	M	M	M	M	M	M	M	M	M	53	67	M	M	
0640	HARRINGTON, MATHEW J.							M	M	NM	M	M	M	50	53	M	18	27	25	M	M	
0775	JOHNSTON, SANDRA A.							M														M
0845	JONES, FRANK I.							M														M
0900	LABRUZZO, ANTOINETTE							M														M

Figure 5. Unit performance profile. (Continued)

SCHOOL: DAVIDSON ELEMENTARY UNIT PERFORMANCE PROFILE AS OF 2/10/73
UNIT: M

WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

WORD ATTACK SKILLS

NUMBER	NAME	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C3 → C12	C13	C14	C15	C16	C17	C18	ALL C MASTERY
0035	ABBOTT, WILLIAM A.	NM	42	M	63															
0075	ADLER, PATRICIA A.																			
0130	ALEXANDER, JOHN T.	M	M	M	M	24	M	M	M	M	M	40	M	M	M	M	44	M	M	
0190	BARNES, PATRICIA L.																			M
0205	BILLINGSLEY, LAURA A.	M	M	M	M	M	M	M	M	M	M	53	M	M	M	M	M	M	M	
0320	DEBOER, ROGER																			
0335	DELANEY, JANET R.	M	54	M	M	M	M	M	73	M	M	73	M	M	69	M	69	M	73	
0340	FRANKEL, STEVEN																			
0415	FRUSHER, KITTY	M	M	M	M	53	60	53	M	53	67	60	M	67	63	M	M	NM	M	
0420	FULLER, TIMOTHY K.	M	M	M	M	M	73	60	M	M	M	53	M	M	M	M	M	M	M	
0535	GEMPELER, THOMAS Q.	NM	50	M	10	59	67	60	67	53	53	M	67	M	56	M	56	NM	M	
0640	HARRINGTON, MATHEW J.																			
0775	JOHNSTON, SANDRA H.	M	M	M	M	M	M	73	M	53	M	53	M	M	M	M	M	M	M	
0845	JONES, FRANK I.	NM	75	M	77	M	53	67	M	67	53	67	M	M	M	M	63	M	M	
0900	LABRUZZO, ANTOINETTE	M	M	M	M	M	M	M	M	M	M	40	M	M	M	M	M	M	M	

Figure 5 (Cont.). Unit performance profile. (Continued)

OOL: DAVIDSON ELEMENTARY

UNIT: M

UNIT PERFORMANCE PROFILE

WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

WORD ATTACK SKILLS

AS OF 2/10/73

NUMBER	NAME	D1	D2	D3	D4	D5	D6	D7	ALL D MASTERY	TOTAL ABCD MASTERY
0035	ABBOTT, WILLIAM A.									17
0075	ADLER, PATRICIA A.									12
0130	ALEXANDER, JOHN T.					75				34
0190	BARNES, PATRICIA L.				33	M	M	M		40
0205	BILLINGSLEY, LAURA A.				47	M	61	78		37
0320	DEBOER, ROGER									12
0335	DELANEY, JANET R.									31
0340	FRANKEL, STEVEN									11
0415	FRUSHER, KITTY									27
0420	FULLER, TIMOTHY K.				33					34
0535	GEMPELER, THOMAS Q.									22
0640	HARRINGTON, MATHEW J.									13
0775	JOHNSTON, SANDRA H.					M		78		35
0845	JONES, FRANK I.									28
0900	LABRUZZO, ANTOINETTE				40	M	67	M		38

Figure 5 (Cont.). Unit performance profile.

that level has been achieved. Nonmastery scores are presented in order that the teacher may be aware of how close the student came to mastery. The report format has some features which enhance its use for placing students in established skill groups and for establishing small ad hoc skill groups. The sequencing of skills and the clustering of skills are indicated graphically. Thus, in Figure 5 the box around A1 and A2 indicates that those skills may be taught together; similarly, the box around C8, C9, C10, and C11 indicates that those skills may be taught together. The arrow between B3 and B4 indicates that B3 should be taught before B4; the arrows between B11, B12, and B13 indicate that the teaching of B11 should precede B12 and B12 should precede B13. The unit (or class) performance profile report is the mechanism for making standard performance data readily available on a periodic basis (weekly) for diagnostic purposes. Other diagnostic information is supplied in the form of management by exception reports.

Student performance and progress is systematically monitored. Reports are issued listing students whose performance or progress has exceeded the threshold values established for the parameters being monitored. Figure 6 illustrates a report that is issued weekly, if required; it lists the students who have not mastered a skill for six or more weeks. Figure 7 shows a report that is issued at the end of the first semester. It lists the names of students who have deviated from teacher-student expectations by two or more skills. A similar report is issued at the end of the school year. The management by exception reports, as their name implies, alert the teacher to students whose performance has deviated, in either direction, from some norm or from what was expected for that student. If the teacher then agrees that the situation warrants attention, she can take corrective action. The management by exception concept is productive in that the teacher is not required to shift constantly through large masses of data to detect deviations.

SCHOOL: LAKEWOOD ELEMENTARY
TEACHER: E. BROWNING

DIAGNOSTIC REPORT

AS OF MARCH 2, 1973

WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

STUDENTS WHO HAVE NOT MASTERED A SKILL FOR SIX OR MORE WEEKS

NUMBER	NAME	LAST SKILL MASTERED	DATE
1358	DAVIS, MICHAEL T.	B-8	DECEMBER 15, 1972
1236	DENTON, JAMES S.	B-10	JANUARY 19, 1973
1379	LEHMANN, DENNIS P.	C-1	JANUARY 19, 1973
1204	NASH, KIRSTIN M.	C-2	JANUARY 12, 1973
1362	REMINGTON, ELIZABETH R.	C-1	JANUARY 19, 1973

Figure 6. Diagnostic report--students who have not mastered a skill for six or more weeks.

CHOOL: NORTHBROOK ELEMENTARY
EACHER: J. SEVERSON

DIAGNOSTIC REPORT

AS OF JANUARY 3, 1973

WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

STUDENTS WHO HAVE DEVIATED FROM ANTICIPATED NUMBER OF FIRST SEMESTER SKILLS BY TWO OR MORE

NUMBER	NAME	ANTICIPATED # OF SKILLS TO BE MASTERED 1ST SEMESTER	ACTUAL # OF SKILLS MASTERED	DIFFERENCE BETWEEN ANTICIPATED AND ACTUAL # MASTERED
1092	HARTLEY, JOHN F.	8	6	-2
1014	HOLDEN, ANDREA E.	2	4	+2
1560	LEVIN, PHILLIP A.	5	2	-3
1302	SPRECHER, GORDON B.	3	5	+2
1216	THIESEN, PAUL E.	7	5	-2
1534	WEBER, JULIE A.	7	4	-3

Figure 7. Diagnostic report--students who have deviated from anticipated number of first semester skills by two or more.

Also, the deviations are brought to the surface early enough to prevent significant deviations from occurring.

Appropriate corrective action might include the utilization of the district's supportive services personnel. Or it might consist of utilizing paraprofessionals such as teacher aides or volunteer mothers for conducting periodic motivational reading conferences. The Wisconsin R & D Center publication, A Guide for Adult-Child Reading Conferences (Klausmeier, Jeter, & Nelson, 1973), is instructive in how to set up and implement such conferences.

For students who have surpassed stated teacher expectations, the teacher might prescribe enrichment work or might assign the student as a tutor to a student who would benefit from one-to-one interaction with a peer. If the teacher feels that the advanced student would benefit in the tutor role, she has him read Tutoring Can Be Fun (Klausmeier, Jeter, & Nelson, 1972), which describes the processes and gives practical examples.

SPECIFYING PERFORMANCE EXPECTATIONS

In the previous section, it was seen that teacher-student performance expectations are constantly monitored and that deviations result in the generation of a management by exception report. Establishing goals for individual students is implicit throughout the instructional programing model. Increasing a child's self-direction and his motivation to learn are major objectives of teacher-student goal setting. The theoretical underpinnings and procedures for conducting teacher-student goal setting conferences have been developed in IGE (Klausmeier et al., 1973). Since the teacher's input to goal setting is based on her professional judgment of the student's capability and potential, utilizing all available achievement and aptitude data, deviations from the goals can be diagnostic, both in the case of individuals and for subgroups of the student population.

Figures 8 and 9 illustrate how information concerning teacher expectations for individual students is entered into the computer and how information concerning the attainment of these individual objectives is reported back to the teacher. Early in the year, the computer generates an <u>expectations of student performance</u> printout for each teacher (Figure 8) on which the teacher is asked to record for each student an expectation of how many skills the student will probably master during the first semester and how many skills he will probably master during the second semester. These expectations are made in cooperation with the student during a teacher-student conference. In making such expectations, the teacher is encouraged to utilize any information he may have on the student which is related to reading aptitude and level of motivation. One such relevant item of information, number of skills mastered to date, which is also expressed as the approximate level of skill mastery, is given on the expectations of classroom performance printout. Within a few days after completion, the updated printout is delivered to the teacher; it contains the expectations she has made for the individual students in the form of an expected level of skill mastery. At the end of the first semester, the printout is updated with the actual first semester performance (Figure 9). A similar printout is generated after the second semester.

At various times during the school year, teacher-student conferences are held to assess progress toward skill attainment. For such sessions, the weekly updated unit performance profile report (Figure 5) and the latest version of the expectations of student performance report (Figures 8 and 9) are utilized.

L: NASHTON
B
TEACHER: A. JONES

SPECIFYING PERFORMANCE EXPECTATIONS

WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

WORD ATTACK SKILLS

AS OF SEPTEMBER 21, 1973

EXPECTATIONS OF STUDENT PERFORMANCE

		BASELINE	FIRST SEMESTER			END OF SCHOOL YEAR		
STUDENT NUMBER	STUDENT'S NAME LAST, FIRST	NO. OF SKILLS MASTERED	EXPECTED NO. OF SKILLS TO BE MASTERED	ACTUAL NO. OF SKILLS MASTERED	TOTAL NO. OF SKILLS MASTERED	EXPECTED NO. OF SKILLS TO BE MASTERED	ACTUAL NO. OF SKILLS MASTERED	TOTAL NO. OF SKILLS MASTERED
0679	ANDREWS, STAN	40	____			____		
0783	BAKER, CANDICE	38	____			____		
0734	HYDE, ANDREW	35	____			____		
0412	APLOW, MIKE	30	____			____		
0792	BELLOWS, ELLEN	28	____			____		
0478	MANNING, KATHLEEN	25	____			____		
0867	GEROO, LINCOLN	19	____			____		
0580	TRACY, JOHN	15	____			____		
0374	VANKER, PAUL	13	____			____		
0802	WALKER, CLOQUET	10	____			____		

Figure 8. Specifying performance expectations (printout for input).

OL: NASHTON
: B
TEACHER: A. JONES

AS OF JANUARY 25, 1974

SPECIFYING PERFORMANCE EXPECTATIONS

WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

WORD ATTACK SKILLS

EXPECTATIONS OF STUDENT PERFORMANCE

		BASELINE	FIRST SEMESTER			END OF SCHOOL YEAR		
STUDENT NUMBER	STUDENT'S NAME LAST, FIRST	NO. OF SKILLS MASTERED	EXPECTED NO. OF SKILLS TO BE MASTERED	ACTUAL NO. OF SKILLS MASTERED	TOTAL NO. OF SKILLS MASTERED	EXPECTED NO. OF SKILLS TO BE MASTERED	ACTUAL NO. OF SKILLS MASTERED	TOTAL NO. OF SKILLS MASTERED
0679	ANDREWS, STAN	40	5	5	45	COMP.		
0783	BAKER, CANDICE	38	7	7	45	COMP.		
0734	HYDE, ANDREW	35	8	8	43	16		
0412	APLOW, MIKE	30	7	6	36	14		
0792	BELLOWS, ELLEN	28	6	7	25	12		
0478	MANNING, KATHLEEN	25	5	5	30	11		
0867	GEROO, LINCOLN	19	5	6	25	10		
0580	TRACY, JOHN	15	4	4	19	8		
0374	VANKER, PAUL	13	3	3	16	6		
0802	WALKER, CLOQUET	10	2	3	13	5		

Figure 9. Specifying performance expectations (with first semester results.)

MONITORING THE EDUCATIONAL PROCESS--SYSTEM DIAGNOSIS

The determinations of whether or not an optimum learning environment has been established and whether or not maximum use is being made of school resources are continually evaluated. Responsibility for quality control functions is shared by the staff of the I & R unit, the IIC of the building, and the SPC of the district. Such determinations involve the evaluation of the relative effectiveness of competing instructional strategies and procedures and the determination of whether various subgroups of the student population are achieving mastery levels consistent with their abilities and goals.

Performance expectations of individual students and their actual performance are combined and summarized for various subgroups of the school population. These reports are updated during the school year and are distributed to the appropriate instructional decision makers. For example, early in the school year the unit teachers receive for their units a baseline performance profile; they then receive an expected profile at the end of the first semester and at the end of the year (Figure 10). Each unit is divided into three groups, ranking the students in order of their baseline skill level. Thus, a unit of 90 students would be divided into three groups of 30 students each. The first group of 30 students would begin the school year at the lowest level of skill mastery; the third group of students would begin the school year at the highest level of mastery in the class. The reason for dividing the class into three is the assumption that the unit staff can better assess the program if assessment information refers in at least a minimal manner to the types of students in the unit. The computer synthesizes similar information in terms of unit level by district. These sets of printouts are

SCHOOL: KENSINGTON
UNIT: D

GROUP INSTRUCTIONAL OBJECTIVES

BY UNIT

WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

WORD ATTACK SKILLS

AS OF MAY 5, 1973

	BASELINE PROFILE		EXPECTED PROFILE FIRST SEM.		ACTUAL FIRST SEM. PROFILE		EXPECTED PROFILE YEAR END		ACTUAL YEAR END PROFIL	
CLASS GROUPS	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL	AVERAGE NO. OF SKILLS MASTERED	APPROX SKILL LEVEL
FIRST GROUP	15	B-8	18	B-11			21	C-1		
SECOND GROUP	25	C-5	31	C-11			37	C-17		
THIRD GROUP	35	C-15	43	D-5			45	D-7		

Figure 10. Group instructional objectives by unit (with expected profile data).

generated and distributed three times a year, with the information indicated, in accordance with the following schedule: baseline data and expectations at the beginning of the year; baseline data, expectations, and actual first semester performance at the end of the first semester; and baseline data, expectations and first semester and year-end performance at the end of the school year.

Figures 11 and 12 illustrate the end-of-year printouts for various subgroups of the student population. Figure 11 is an example of a printout for a unit. This printout is for the unit staff and the IIC. Figure 12 is an example of a printout which considers all students at a given unit level throughout the school district. This printout is for the IIC of each building and the SPC of the district.

DATA BASE INITIATION AND MAINTENANCE

At the start of the project, it is necessary to establish a master record in the computer for each student. The master record contains demographic data as well as student performance data and teacher expectations of pupil performance on the various components of the WDRSD. Fields 1 through 8 of the WDRSD data element requirements (see Appendix A) are suggestive, but not exhaustive, of the type of demographic data which may be recorded for each student. The amount of demographic data will increase with the development of the administrative and research components of the CMI system.

Student performance data are generated by the results obtained from the criterion-referenced tests of the WDRSD. Each test is appropriate for individual as well as group administration. Group testing is used when implementation of the WDRSD design begins (Break-in testing) and at fairly wide-spaced intervals thereafter. The tests are used with individuals at any time the formal

SCHOOL: KENSINGTON
UNIT: D

GROUP INSTRUCTIONAL OBJECTIVES

AS OF MAY 30, 1973

BY UNIT

WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

WORD ATTACK SKILLS

	BASELINE PROFILE		EXPECTED PROFILE FIRST SEM.		ACTUAL FIRST SEM. PROFILE		EXPECTED PROFILE YEAR END		ACTUAL YEAR END PROFILE	
CLASS GROUPS	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL
FIRST GROUP	15	B-8	18	B-11	17	B-10	21	C-1	20	B-13
SECOND GROUP	25	C-5	31	C-11	32	C-12	37	C-17	38	C-18
THIRD GROUP	35	C-15	43	D-5	44	D-6	45	D-7	44	D-6

Figure 11. Group instructional objectives by unit (with first semester and year-end data).

SCHOOL: DISTRICT-WIDE
UNIT: INTERMEDIATE PRIMARY

GROUP INSTRUCTIONAL OBJECTIVES

AS OF MAY 30, 1973

UNIT LEVEL BY DISTRICT

WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

WORD ATTACK SKILLS

	BASELINE PROFILE		EXPECTED PROFILE FIRST SEM.		ACTUAL FIRST SEM. PROFILE		EXPECTED PROFILE YEAR END		ACTUAL YEAR END PROFILE	
CLASS GROUPS	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL	AVERAGE NO. OF SKILLS MASTERED	APPROX. SKILL LEVEL
FIRST GROUP	14	B-7	17	B-10	15	B-8	30	C-10	28	C-8
SECOND GROUP	23	C-3	29	C-9	23	C-3	40	D-2	36	C-16
THIRD GROUP	30	C-10	39	D-1	34	C-14	45	D-7	43	D-5

Figure 12. Group instructional objectives at unit level by district.

assessment of any given skills is felt to be desirable. At data base initiation time, available student performance data are transcribed from existing records to forms which will expedite transfer to computer storage. Most often, the existing record is the card-sort profile card.

The baseline performance data sheet (Figure 13) permits relatively straightforward transcribing of data from the card-sort profile card to a format which will expedite keypunching. A baseline performance data sheet must be filled out for each element of WDRSD (Word Attack, Study Skills, Comprehension) for which data are available. The appropriate letter is entered in the third column to indicate the highest level that a student has completed. The letter indicating the level at which the student is currently working is entered in the fourth column. In the remaining columns (numbered 1 through 18), performance data are entered for the corresponding skills.

Performance data on written tests are entered in terms of raw scores. At times, raw score data on written tests may no longer be available but mastery (M) or nonmastery (NM) data may be available. If so, such data are entered on the data sheet and M or NM are also indicated for those skills for which there are no written tests and for which assessment is by means of teacher observation on performance tests.

Once the data base has been initiated, it is necessary to update it periodically as students take the WDRSD criterion-referenced tests to demonstrate skill mastery. The average student masters a skill every two or three weeks, and students take tests when it is felt that they can demonstrate mastery. The single sheet criterion-referenced tests are scored by teacher, teacher aide, or student. The results must then be entered into the computer. It is not necessary to enter scores into the computer more often than once a week. Each update of pupil performance data results in the generation of

Wisconsin Design for Reading Skill Development

BASELINE PERFORMANCE DATA

ELEMENT

Word Attack ( )
Study Skills ( )
Comprehension ( )

School ______

Grade or Unit ______

Teacher ______

Date ______

Code: TC=Teacher Certification; TO=Teacher Observation or no raw score available; M=Mastery; NM=Non-mastery

STUDENT																				
Number	Name	Comp. Level	Present Level	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Figure 13. Baseline performance data sheet (input form).

a unit performance profile report (Figure 5). This will result in a data base which is sufficiently current to permit regrouping of students into appropriate instructional groups every two or three weeks.

Figure 14 shows a form on which the teacher or teacher aide might record test results in a batch system in which the results are to be entered via keypunching. The computer would generate the class roster as illustrated, and the teacher would enter the area, level, skill, and raw score beside the student name. The keypunch operator would enter the student number but ignore the student name. In a batch environment, this particular form would be a high priority candidate for early conversion to mark-sense input, as it is the most frequently used form in the system and the nature of the data that are not computer generated (it is assumed that student number and name will continue to be computer generated) can be adequately handled by the mark-sense technology which is characteristic of central site facilities.

In an on-line teletype-like environment, the raw test score would be reported in the following manner: The teacher or teacher aide would indicate via keyboard entry that raw scores were to be entered for a particular unit or class. The computer would present student names, one at a time. The teacher would then enter, when scores are available, a one-letter code for area, a three-character code for level and skill, and two digits for raw score. To further simplify data entry, a default condition would be implemented where, if no area and/or level-skill entry were made, that of the previous student would be assumed since pupils are often tested on the same skill in small groups.

It should be noted that in the information flow discussed here, no provision is currently made for the computer scoring of tests. This is a departure from most CMI system designs in which the computer scoring of tests is one of the earliest implemented functions. The decision not to computerize test scoring

SCHOOL: UNION HIGH RAW TEST SCORES FORM AS OF APRIL 26, 1973
TEACHER: R. SHOWERS
LEVEL B WISCONSIN DESIGN FOR READING SKILL DEVELOPMENT

STUDENT #	NAME	AREA (WA, SS, OR COMP)	LEVEL + SKILL	*RAW SCORE
1840	DAVID, JOHN			
1895	WARPINS, CHARLES			
0005	ADAMS, GUNVOR			
0065	FRAME, STEPHEN			
0185	BROWNE, ORA			
0665	TERRY, JAMES			
0685	HOLMES, RODNEY			
0825	KELTNER, PAMELA			
0865	LAPLANTE, JENNY			
1005	MATSON, THOMAS			
1025	MCKANNA, CANDACE			
1135	KORPAL, MARILYN			
1145	MILLER, KEITH			
1175	NORTHROP, KERRIE			
1540	SANGER, RICHARD			
1625	STRONG, ERICA			
1730	WARNER, DAVID			
1760	WALTON, LIONEL			
1845	WESTERN, KAREN			
1880	ZIMMERMAN, JON			

*RAW SCORE: TC = teacher certification; or M = mastery; or NM = nonmastery

Figure 14. Raw test scores form.

is based on many considerations. Central to the decision is a design philosophy which insists that the emphasis on utilizing computer resources be on making possible better decisions than could be made without a computer rather than on automating trivial clerical tasks. The scoring of the one-sheet criterion-referenced tests by teacher, teacher aide, or student is a relatively straightforward task. A second consideration is the psychological principle that reinforcement is most effective in learning when it is immediate and specific. When the test is scored in the classroom, the student can have immediate feedback on his performance on each item. In a batch-processing environment, immediate feedback would not be possible. To provide the required completeness of feedback in an on-line system would require high utilization of computer and communication resources as well as the availability of an appropriate mark-sense device at the remote terminals.

INFORMATION FLOW SUMMARY

Currently, four types of forms are utilized by the teacher to input data into the data base or to request data: (1) baseline performance data, (2) raw test scores, (3) expectations of student performance, and (4) skill grouping request.

The data base in terms of achievement data (scores on the criterion-referenced tests of WDRSD) is initiated from the data supplied by the teacher on the baseline performance data sheet (Figure 13). This sheet is also used to update the data base after group testing when a number of tests (administration of test booklets) are administered to each pupil. Such periodic group testing sessions generally occur at periods of a year or more. During the course of the year, as a student completes a specific skill the appropriate criterion-referenced test is administered. These scores are entered on the raw test scores report (Figure 14) and are submitted to the computer center on a weekly basis. The skill grouping request triggers the specific grouping report (Figure 4). Early in the school year, the teacher submits on the expectations of student performance form (Figure 8) the number of skills each student is expected to complete in the first and second semester.

Five types of reports are generated to present information to teachers and other members of the school staff:

1. The unit performance profile (Figure 5) is issued weekly, and it reflects the updated data base resulting from the submission of the raw test scores form. The unit performance profile summarizes for the teacher the achievement of each student in his unit, and it serves as a basis for monitoring the progress of students.
2. The specific grouping report lists the students who are eligible to be placed in that group, and it also lists the prerequisite skills.
3. The expectations of student performance reports (Figures 8 and 9) are updated and issued three times a year: soon after the teacher completes and submits the expectations of student performance form (Figure 8), after the first semester (Figure 9), and at the end of the school year. These reports compare the results anticipated by the teacher with the obtained results.
4. The group instructional objectives reports (Figures 10 through 12) are also issued three times a year, and they summarize expectation and performance data in terms of a low, middle, and high group. Separate reports are issued for individual units and for units at the same level in the school district. The reports are issued early in the school year, after the first semester, and after the second semester.
5. The management by exception reports include the report for students who have not mastered a skill for six or more weeks (Figure 6) which is

issued when applicable on a weekly basis and the report for students who have deviated from anticipated number of skills (Figure 7) which is issued twice during the year--after the first and second semesters.

The information flow is characterized by a periodic reporting scheme and a small number of management by exception reports. There is only one ad hoc request for information, the skill grouping request. This mix of reports has been proposed in order to provide the required management information while minimizing demands on computer resources and thus maximizing the number of schools that can be serviced by a given computer system.

The function, the information content, and the periodicity of the forms and reports currently proposed for the computer management of WDRSD are summarized in Appendix B.

III

COMPUTER MANAGED INSTRUCTION AND THE DEVELOPING MATHEMATICAL PROCESSES PROGRAM

The WIS-SIM model presented in Chapter I emphasized the decision area of specifying appropriate educational experiences. The reports resulting from the two processes of diagnosing and prescribing are of primary concern in supplying information to school personnel which facilitates the making of this decision. This chapter will focus on the information provided by the CMI system as applied to the Developing Mathematical Processes (DMP) program. First, an overview of the DMP program will be presented, followed by a discussion of the reports produced to assist in the specification of appropriate educational experiences; finally, consideration will be given to data base initiation and updating.

THE DEVELOPING MATHEMATICAL PROCESSES PROGRAM

DMP is a research-based, elementary mathematics program currently under development by the Analysis of Mathematics Instruction project of the Wisconsin R & D Center. The developmental process includes classroom testing and validation in an increasingly large number of schools; this will culminate in large-scale field tests involving several hundred schools (DMP Sampler, 1972). The design conforms to the concept of IGE described by Klausmeier and others (1971). In IGE, instructional programs developed to meet the needs and characteristics of each elementary-school child call for activities in various group sizes: large group, small group, pairs, and individual work with instructional materials.

DMP is basically an activity approach to learning mathematics. Although activity learning has been advocated for many years by some teachers and psychologists, DMP is the first serious effort to incorporate this learning approach in a carefully sequenced, complete program of mathematics instruction for grades K-6 (DMP Sampler, 1972). It is felt that activity learning is the most sensible way for children to learn about quantitative and geometric ideas. In addition, this approach allows the teacher to make choices about what kinds of activities are best suited for each child in the class in terms of development, learning style, and temperament.

Another innovation is the inclusion of geometric ideas at all levels of instruction. The geometry is not the formal geometry studied in tenth grade; rather it is an informal, intuitive look at size, shape, and relationships among two- and three-dimensional objects. A serious attempt is made in the instructional materials to integrate geometry and arithmetic.

This integration is accomplished partly because of another characteristic of DMP: mathematics is developed through a measurement approach. In DMP's measurement approach, the student examines the objects in his world and focuses on some of their attributes (length, numerousness, weight, capacity, area, volume, or time). He uses various processes (describing, classifying, ordering, equalizing, joining, separating, grouping, and partitioning) to explore relationships among real objects. Once the student is familiar with the attributes, he symbolically represents (measures) them. Likewise, he symbolically represents the relationships among them with mathematical sentences. In turn, the student takes mathematical sentences and models them with real objects. Thus, the connection between abstract mathematics and the real world is continually emphasized as the student solves problems. Because some attributes are characterized by direction as well as size, the study of positive and negative integers is begun rather early--at approximately third-grade level. Since the children are constantly generating numerical data, it is considered appropriate to study certain elementary notions of probability and statistics so data can be organized and analyzed.

The instructional approach in DMP is through a series of behavioral objectives. For each behavioral objective, instructional materials, activities, and teaching techniques must be selected or developed. Central to the instructional management function is the development of pupil assessment instruments for each behavioral objective. These measurement instruments are criterion-referenced tests since the purpose of the tests is to measure a desired student behavior or level of competence.

The complete DMP program will include curriculum packages for K-6 and will consist of 96 topics of instruction grouped into seven levels with approximately 12 topics in each. The topics will have an average of three to four behavioral objectives. The average students should complete a topic in two or three weeks.

Assessment in DMP is geared toward mastery of behavioral objectives. Only three levels of performance are reported: mastery (M), making progress toward mastery (P), and needs considerable help (N). Numerical scores are never used. Performance is evaluated and reported in terms of these three categories regardless of the method of assessment.

SELECTING APPROPRIATE EDUCATIONAL EXPERIENCES

The factors that are relevant in establishing optimal learning environments in WDRSD are operational in DMP (Belt, Marshall, & Romberg, 1972). The broad spectrum of available instructional experiences include independent study, teacher-student counseling sessions, tutorial sessions, activities in small to medium-sized groups, and large group sessions. The instructional programs in IGE rely heavily on the small to medium-sized activity group since this group size appears to be efficient and effective because the interaction which takes place can be highly motivational and can produce positive social and cognitive outcomes. The small to medium-sized activity group is especially predominant in DMP due to the heavy emphasis on activity learning as contrasted with other mathematical curricula. Teachers are assigned to activity groups on the basis of their expertise and interest in teaching that activity. The placing of children into appropriate instructional groups is based on relevant diagnostic and prescriptive information. The prescription considers the individual student's diagnosis, the sequencing and clustering characteristics of the curriculum, and the availability of school resources (space, materials, and personnel).

The sequencing of topics within DMP is based on a task analysis (Romberg, Harvey, & McLeod, 1970) which is performed for each level of DMP. Since DMP makes especially heavy use of instructional manipulatives and experimental setups, the logistics associated with space and instructional materials is especially critical. Thus, an essential management function is to integrate student readiness with appropriate available teachers, space, and instructional resources. Not all elements of the prescription equation are of equal importance; student readiness must be of primary concern. The CMI design not only attempts to make student readiness information easily available to teachers; it also makes available reports which focus on specific deficiencies.

Figure 15 illustrates the instructional grouping recommendation report. This report is the one that is most useful in establishing appropriate instructional experiences. It lists all students who have the prerequisites for a specified topic. It also indicates the prerequisites for that topic. Figure 16 shows the topic deficiency report. This report identifies prerequisite deficiency in terms of a specific topic. The deficiency may be that the student has failed to achieve mastery of specific prerequisite objectives, or that the student has not yet undertaken the study of the objectives, or a combination of both. Thus, this report serves a dual diagnostic and prescriptive role. It pinpoints specific difficulties, and it indicates the sequence of objectives that is required to obtain mastery on a given topic. Both of these reports are obtained by means of the grouping information request form (Figure 17).

Information can be requested in terms of a particular instructional group or in terms of an entire unit (or class). This form also permits the requesting of a list of students who have started a given topic. In an on-line implementation of the system, the grouping information request form could be submitted to the computer through a mark-sense terminal in the school or by direct interaction on a teletype. The form depicted in Figure 17 conforms to the Hollerith card format.

The reports that have just been discussed relate in a significant way to the instructional grouping process which is a rather direct method of establishing appropriate learning environments. The effectiveness of

INSTRUCTIONAL GROUPING RECOMMENDATION

PREREQUISITES FOR TOPIC 4.3

1) P OR M ON OBJECTIVES 1-7 IN TOPIC 3.8
2) P OR M ON OBJECTIVES 1-3 IN TOPIC 3.10

THE FOLLOWING PUPILS ARE READY FOR TOPIC 4.3:

BLISS KEVIN
BOBZIEN RANDY
CALKINS SUE
DRANSFIELD DUANE
EMERY GEORGE
FLODEEN CARMEN
GODWIN CHRIS
HAYNES JUNE
JARSTAD JAYNE
KETTLE PAM
KLOSSNER DALE
LARSON GREG
LETSON SANDY
LOKRANTZ PAT
MARSDEN CHRIS
MARSHALL JOHN
MCKEOWN NANCY
MCLAIN LINDA
MCLEAN CATHY
NELSEN ANNE
NELSON KATHY
NILSON HANS
RIGGS BETH
ROBERS PAUL
SCHWIEGER MARY
SITAS CINDY
SKARDA JEAN
SKINNER BRUCE
STARKS BART
STOREY THOMAS
STUCKEY PAUL
STURDEVAND TOM
STYVERSON PETER
THOMAS HERMAN

Figure 15. Instructional grouping recommendation.

TOPIC DEFICIENCY REPORT FOR UNIT C

THE FOLLOWING PUPILS ARE NOT READY FOR TOPIC 4.3 BECAUSE ACHIEVEMENT NOT ASSESSED (NA) OR INSUFFICIENT (N). NO MARK INDICATES SUFFICIENT ACHIEVEMENT (M OR P).

	TOPIC	3.8							3.10		
NAME	OBJECTIVE	1	2	3	4	5	6	7	1	2	3
BELL, JOANNE		NA	NA	NA	NA	NA	NA	NA			
BENNETT, JOHN		N		N	N	N			NA	NA	
BRIGGS, HOWARD			N		N				N	N	N
BROGLEY, LAURA		NA	NA		NA				N	N	N
DILUZIO, GENEVA		N	N	N	NA	NA	NA	NA			
CHAMBERS, GILBERT									N		
DEAN, DONALD			N		N						
HAERTEL, ED		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LEASH, BARBARA			N								
MILNE, KRISTIN									N	N	N
SPACKMAN, BARB		N		N		N					
WENDE, JOHN		N	N	N	N	N	N	N	N	N	N

Figure 16. Topic deficiency report.

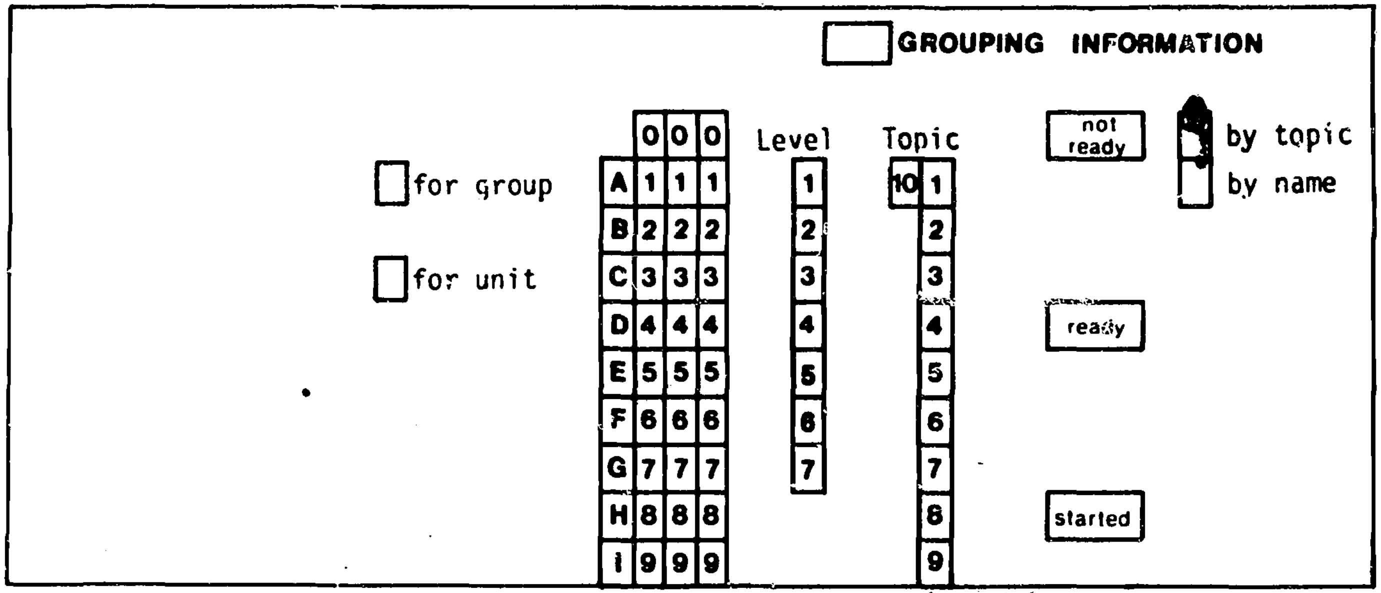


Figure 17. Grouping information request form.

the learning environment is monitored in terms of the progress of individual students as well as in terms of group progress. Achievement profiling permits assessment at the individual student level, and it permits close monitoring of instructional groups as they proceed toward the attainment of educational objectives. Figure 18 illustrates the individual progress sheet, which lists the rating and date each student has been assessed on each objective at a given level. This report, which shows student achievement patterns, is useful in student-teacher conferences. It focuses these conferences on the measurable behavioral objectives and can contribute to the student becoming increasingly responsible for guiding his own educational progress. Presenting reports to parents in terms of behavioral objectives has the virtue of conveying to the home the nature of the student's progress in the educational program with greater clarity than in the conventional letter-grade reporting scheme.

The progress of instructional groups of units (classes) is monitored by means of the group or unit record card report. Figure 19 illustrates the group record card report. Such student achievement profiles enable school personnel to continually monitor achievement of subgroups of the student population and also to make judgments about the effectiveness of particular curricular material or teaching strategies. Both the individual progress sheets (Figure 18) and the group record card (Figure 19) are obtained by means of the pupil performance record request form which is illustrated in Figure 20.

DATA BASE INITIATION AND UPDATING

When the CMI system is introduced into a school, a data base must be established in the computer which reflects the current achievement status of the students in DMP. The school provides the computer center with

INDIVIDUAL PROGRESS SHEET   2/24/73   LEVEL FOUR

RATINGS FROM ALL SOURCES

ZOLTAN PEPPER   UNIT C

TOPIC 4.1 DESCRIBING, CLASSIFYING, AND LOCATING

OBJECTIVE 1 -- SORTS OBJECTS
9/14/72 P
9/29/72 M

TOPIC 4.2 PARTITIONING

OBJECTIVE 1 -- PARTITIONS SET
10/03/72 N
10/07/72 N
10/15/72 M
10/30/72 M

OBJECTIVE 2 -- WRITES PARTITIONING SENTENCE
10/03/72 P
10/04/72 P
10/11/72 P
10/20/72 P
10/30/72 M

OBJECTIVE 3 -- MODELS GROUPING NOTATION
10/03/72 M
10/09/72 M

OBJECTIVE 4 -- STATES FRACTIONAL NAME
10/03/72 N
10/08/72 M
10/30/72 P
10/31/72 M
11/04/72 M

Figure 18. Individual progress sheet.

(Continued)

OBJECTIVE 5 -- MODELS FRACTIONAL NAME

10/03/72 P
10/12/72 P
10/30/72 M

OBJECTIVE 6 -- STATES WHETHER FRACTIONAL PART
10/03/72 P
10/09/72 M
10/30/72 M

TOPIC 4.3 NUMBER SENTENCES 0-99

OBJECTIVE 1 -- WRITES SENTENCE 0-99
10/31/72 M
11/09/72 M

OBJECTIVE 2 -- REGROUPS OBJECTS
10/31/72 N
11/04/72 N
11/07/72 M
11/09/72 P
11/11/72 P

TOPIC 4.4 UNITS OF LENGTH

OBJECTIVE 1 -- ASSIGNS STANDARD LENGTH MEASUREMENT
11/14/72 N
11/18/72 M

TOPIC 4.5 SYMMETRY AND CIRCLES

OBJECTIVE 1 -- STATES WHETHER LINE OF SYMMETRY
2/13/73 P
2/20/73 M
2/21/73 P

OBJECTIVE 2 -- STATES WHETHER SYMMETRIC
2/10/73 P
2/13/73 P

OBJECTIVE 3 -- LOCATES CENTER
NOT YET ASSESSED ON THIS OBJECTIVE

OBJECTIVE 4 -- CONSTRUCTS RADIUS AND DIAMETER
NOT YET ASSESSED ON THIS OBJECTIVE

Figure 18. Individual progress sheet.

(Continued)

TOPIC 4.6 THE ADDITION AND SUBTRACTION ALGORITHM

OBJECTIVE 1 -- WRITES COMPACT SUM 0-99
11/20/72 P
11/24/72 M
12/08/72 P
12/10/72 P
1/08/73 M
1/16/73 M

OBJECTIVE 2 -- WRITES COMPACT DIFFERENCE 0-99
11/20/72 N
11/24/72 P
12/08/72 N
12/10/72 P
12/16/72 P
1/16/73 P

TOPIC 4.7 UNITS OF WEIGHT

NOT YET ASSESSED ON ANY OBJECTIVE

Figure 18. Individual progress sheet.

DMP GROUP RECORD CARD REPORT LEVEL FOUR

GROUP B327 2/05/73

	TOPIC	1	2						3		4	5				6		7
NAME	OBJECTIVE	1	1	2	3	4	5	6	1	2	1	1	2	3	4	1	2	1
ADAMS JOY		M	M	M	M	M	M	P	P	N	P							
ALLBRIGHT JOEY		M	M	M	M	M	M	P	P									
BELL JOANNE					M	M	M											
CRANDELL ARTHUR		M	M	M	M	M	M	N		P								
GREGORIADOS GEORGIA		M	M	M	M	M	M		P									
LANGE PAUL		M	M	M	M	M	P	P	N									
LOCHOWITZ SEAN		M	M	M	M	M	M	M	M	M	M							
SEYFERTH GINA		M	M	M	M	M	M	M	P	P	P							
SORG STEVEN		M	M	M	M	M	M	M	M	M	P	M						
ZAREZECKI SUZETTE		M	M	M	M	M	M	M	P	P	M							

Figure 19. Group record card report.

PUPIL PERFORMANCE RECORD REQUEST, MARK-SENSE FORM.

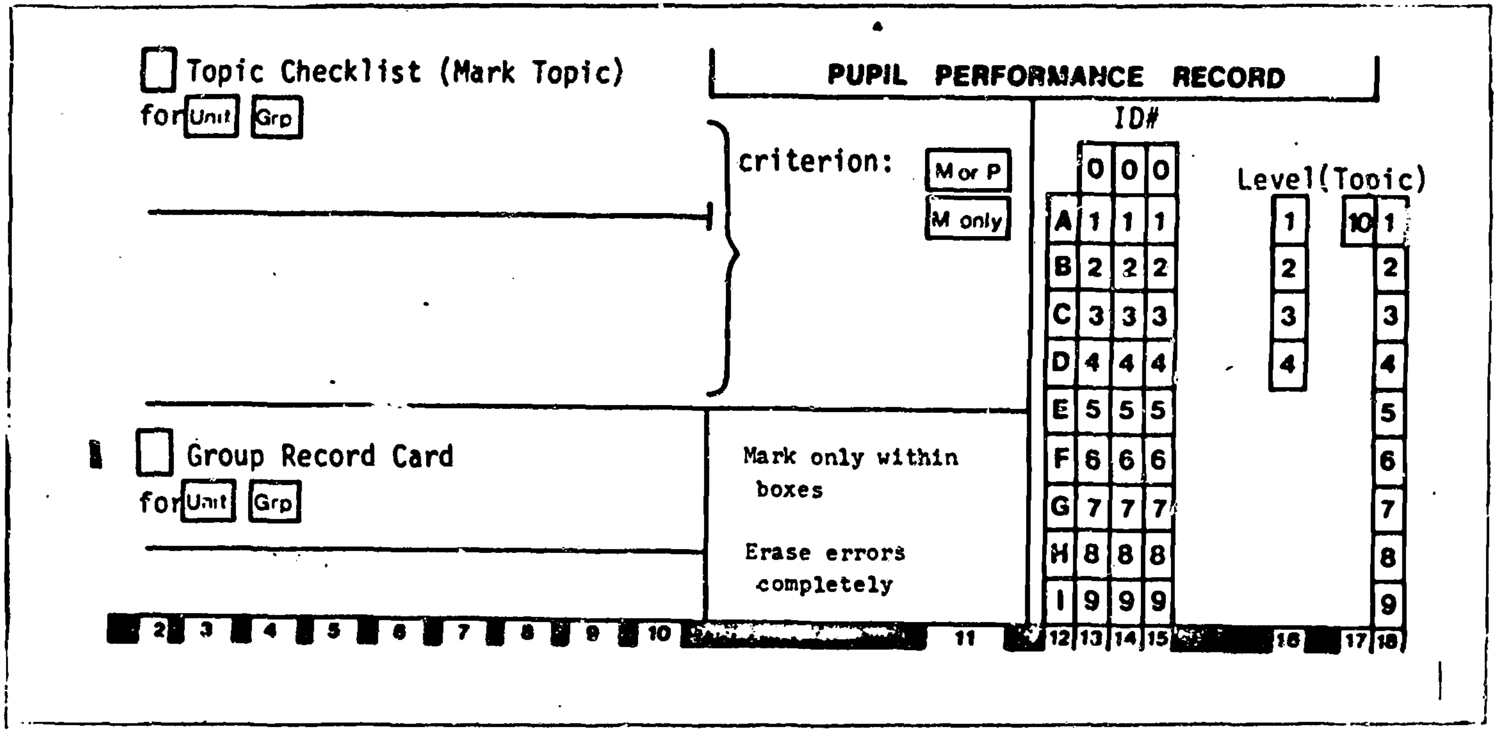


Figure 20. Pupil performance record request.

information on each student including DMP initial placement scores and scores on topics covered before the system was installed. These data are then keypunched at the computer center and used to initialize the computer data base.

Update data are of three types: student performance on DMP objectives, specification of instructional groups, and student-teacher goal setting data.

Assessment in DMP

As the student progresses through the DMP program, his achievement on successive objectives is continually assessed. After initial placement, two methods of assessment are utilized throughout the year—observation schedules and topic inventories. The observation schedules help the teacher assess students' performance through day-to-day observation of their behavior. The topic inventories are formal assessments that can be used for pre-assessment and post-assessment. They are also utilized as part of the placement process.

Since DMP is heavily activity-oriented, pupil progress on most behavioral objectives is observed by the teacher during normal classroom activity. In fact, some objectives can be assessed only by means of teacher observation.

The three performance categories are defined in the DMP assessment manuals as follows (Romberg & Harvey, 1972):

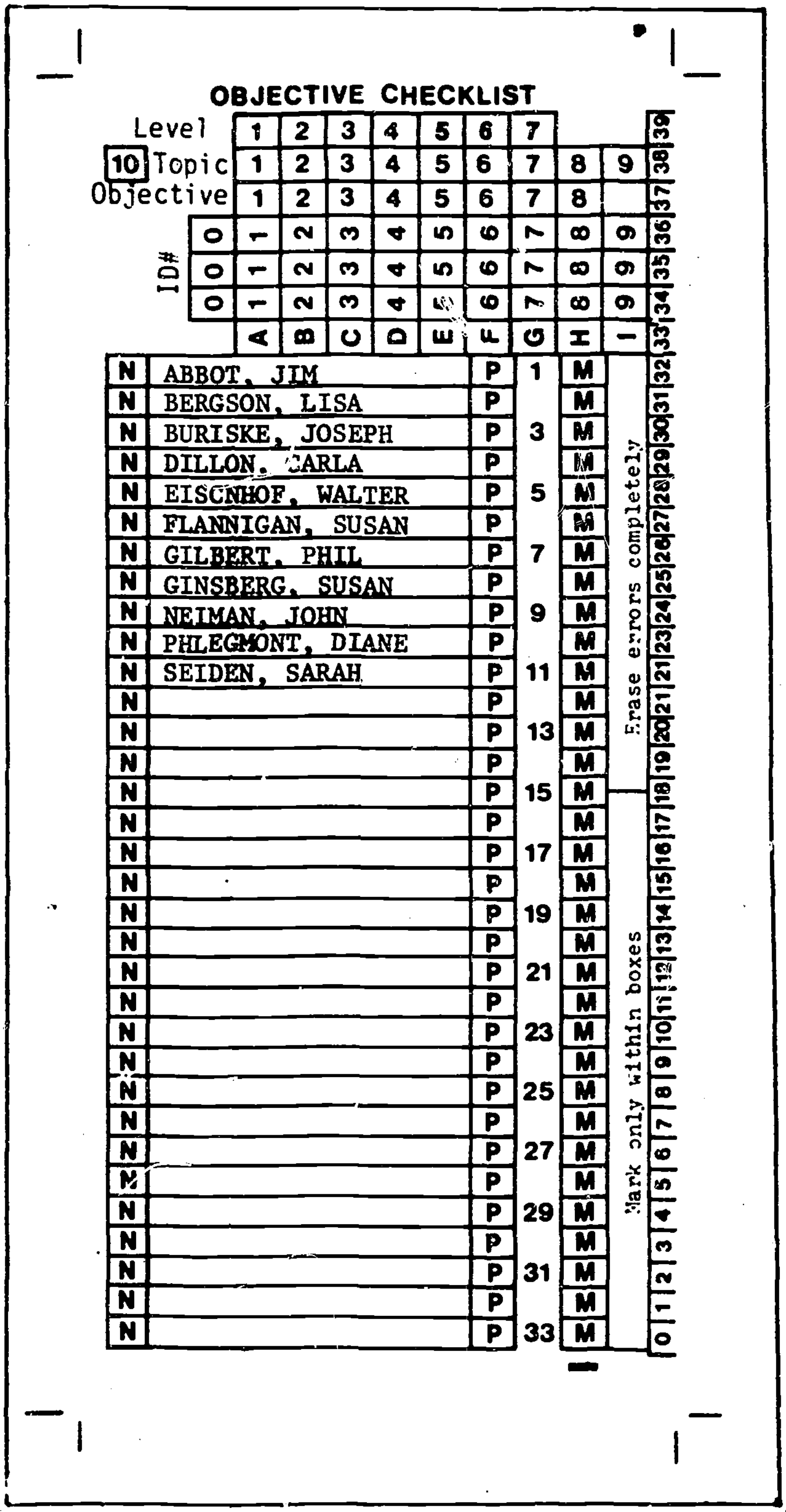
M Mastery	You are convinced by the child's performance on the assessment activity that, given a similar activity, he could exhibit the required behavior.
P Making Progress	Though the child has not mastered the objectives, he is making progress toward that end. Intensive review is not necessary as the child will probably master the objectives as he participates in the activities of the next topics.

N Needs Considerable Help — The child has not mastered the objective and needs individual attention and much extra work.

A group usually spends two to three weeks in instructional activities related to the objectives in a given topic. Usually the teacher will submit performance ratings to the computer on a weekly basis. These ratings may be based on the results of a topic inventory test, teacher observation, or a combination of both. All assessment data are entered in the computer by means of one mark-sense form, the objective checklist (Figure 21). The list of student names depicted in Figure 21 is generated by the school's teleprinter on a self-adhesive label. Since each objective checklist only accommodates one objective, a number of objective checklists are submitted for each instructional group at the same time. Each time a teacher submits objective checklists, she receives an updated topic checklist report (Figure 22). Topic checklist reports may also be obtained by submission of a pupil performance record request (Figure 20).

Selecting Appropriate Educational Experiences--Request Forms

The formation and modification of instructional groups generally takes place during a meeting of the instructional staff of a unit. Prior to the meeting, each teacher obtains an instructional grouping recommendation report (Figure 15) for each topic for which she is to have responsibility. Each unit is provided with a supply of prepunched and preprinted teacher/group ID (Figure 23) and pupil action (Figure 24) mark-sense cards. These two sets of cards are utilized to form new instructional groups and to modify existing ones. If new instructional groups are to be formed, the prepunched and preprinted pupil action cards for



OBJECTIVE CHECKLIST

Level 1 2 3 4 5 6 7

10 Topic 1 2 3 4 5 6 7 8 9

Objective 1 2 3 4 5 6 7 8

ID# 0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

A B C D E F G H I

N	ABBOT, JIM	P	1	M
N	BERGSON, LISA	P		M
N	BURISKE, JOSEPH	P	3	M
N	DILLON, CARLA	P		M
N	EISCNHOF, WALTER	P	5	M
N	FLANNIGAN, SUSAN	P		M
N	GILBERT, PHIL	P	7	M
N	GINSBERG, SUSAN	P		M
N	NEIMAN, JOHN	P	9	M
N	PHLEGMONT, DIANE	P		M
N	SEIDEN, SARAH	P	11	M
N		P		M
N		P	13	M
N		P		M
N		P	15	M
N		P		M
N		P	17	M
N		P		M
N		P	19	M
N		P		M
N		P	21	M
N		P		M
N		P	23	M
N		P		M
N		P	25	M
N		P		M
N		P	27	M
N		P		M
N		P	29	M
N		P		M
N		P	31	M
N		P		M
N		P	33	M

Erase errors completely

Mark only within boxes

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 21 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39

Figure 21. Objective checklist.

TOPIC 3.7 CHECKLIST FOR GROUP C104 11/17/72

OBJECTIVE 1 -- WRITES JOINING OR SEPARATING SENTENCE 0-10

LOUMANS, NEWMAN	NA
NOE, IDA	N
BAKER, CLARA	P
COE, ROCCO	P
DIXON, BENNY	P
JOUSE, CARRIE	P
REYNOLDS, WENDY	P
STAATS, RUTH	P
WENDT, TERRY	P
BENJAMIN, JACQUES	M
EINSTEIN, FRANK	M
FYE, MOLLY	M
GOODBODY, IRIS	M
MUSTHEIM, CHRIS	M

OBJECTIVE 2 -- VALIDATES SENTENCE 0-10

NO ONE HAS YET BEEN ASSESSED ON THIS OBJECTIVE

OBJECTIVE 3 -- SOLVES OPEN SENTENCE 0-10

LOUMANS, NEWMAN	N
NOE, IDA	N
BAKER, CLARA	P
COE, ROCCO	P
DIXON, BENNY	P
JOUSE, CARRIE	P
REYNOLDS, WENDY	P
STAATS, RUTH	P
WENDT, TERRY	P
BENJAMIN, JACQUES	P
EINSTEIN, FRANK	P
FYE, MOLLY	M
GOODBODY, IRIS	M
MUSTHEIM, CHRIS	M

Figure 22. Topic checklist report.

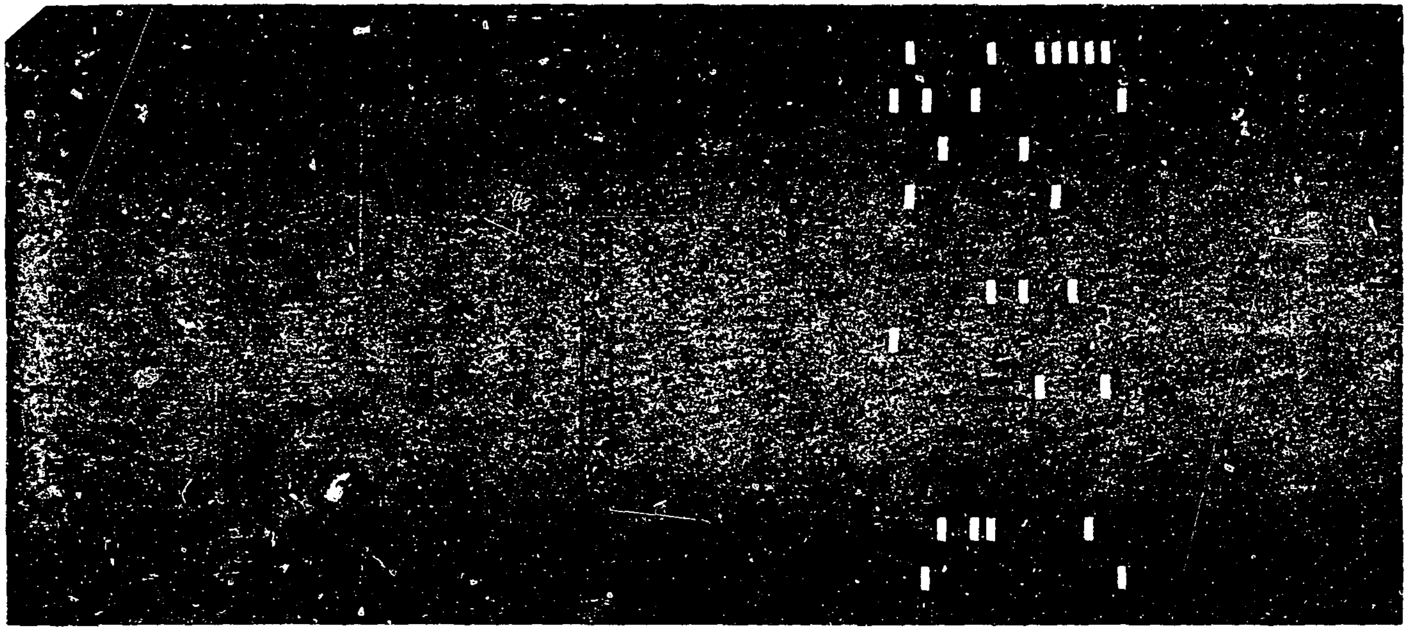


Figure 23. Teacher/Group ID card.

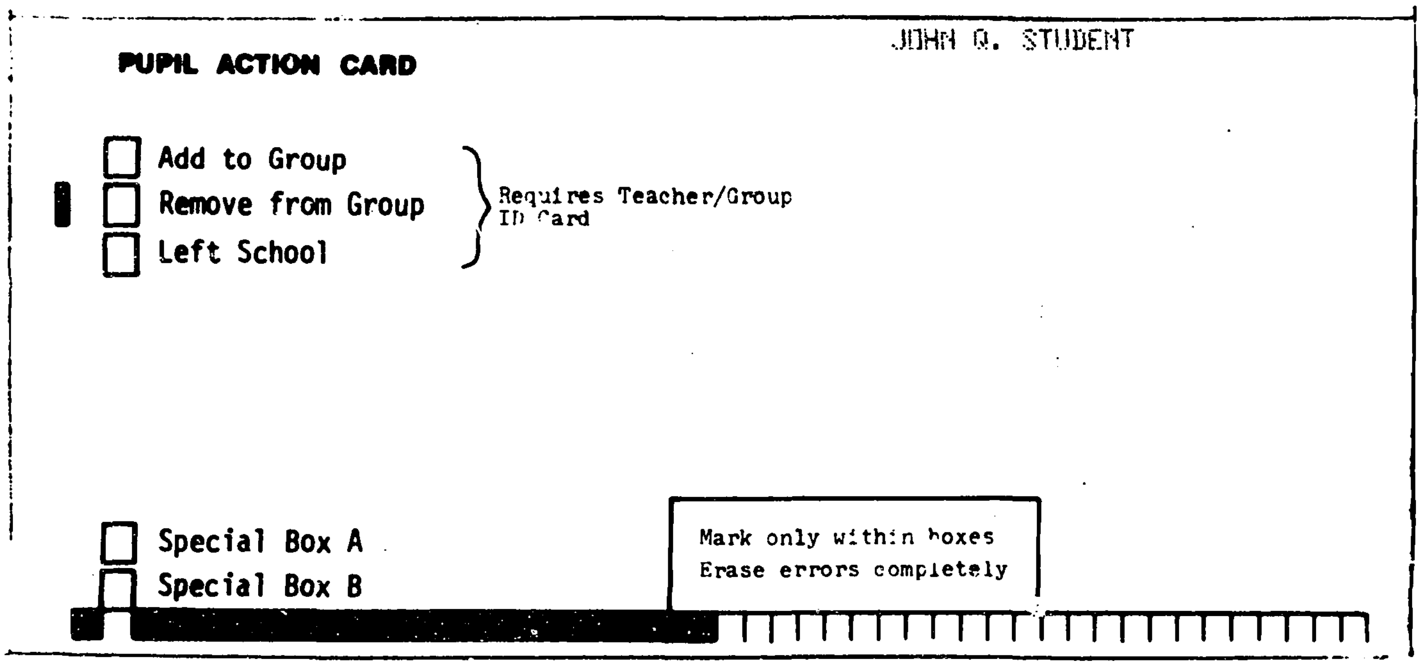


Figure 24. Pupil action card.

those pupils who are to be in a given group are assembled in a deck. Teacher/group ID cards, which identify the teacher who is to have responsibility for the group, are the first and last cards in the deck. Also, on the first teacher/group ID card, an indication is made as to the particular scheduled instructional period (module). The decks of cards are then submitted for input to the mark-sense reader, and new group rosters are generated for the teachers.

When grouping modifications are made, the procedure is essentially similar to the procedures for forming new groups, except a pupil action card for a given student must appear in two decks, one submitted by the receiving teacher and one submitted by the relinquishing teacher. The receiving teacher indicates "add to group" on the pupil action card and the relinquishing teacher indicates "remove from group." After the decks are submitted, the teachers obtain updated group rosters printed on self-adhesive labels to be used in conjunction with the objective checklist mark-sense forms (Figure 21).

Goal Setting for Individual Students

Student-teacher goal setting provides a mechanism for the student to become increasingly responsible for his own educational direction. The data provided by the goal-setting function also provide baseline data for monitoring the progress of individual students as well as for evaluating the educational development of subgroups of the student population. The design of the performance expectation function in WIS-SIM for DMP has as yet not been completed. Appropriate standards and norms for expectations have not been integrated into DMP. It is anticipated that the experimental base resulting from the pilot test of WIS-SIM DMP will provide information required for the development of this component.

INFORMATION FLOW SUMMARY

Five mark-sense formats have been identified for use by classroom teachers: (1) the objective checklist, (2) the grouping information request, (3) the teacher/group ID card, (4) the pupil action card, and (5) the pupil performance record card request.

1. The objective checklist is used to enter all assessment data, and each submission results in the teacher obtaining an updated achievement profile on that objective, the topic checklist report.
2. The grouping information request form is used to obtain reports which expedite the establishment of instructional groups. This diagnostic-prescriptive report lists students who are ready for instruction on a given topic or, alternatively, students who are not ready for a topic (topic deficiency report) together with their associated prerequisite deficiencies. A report may also be obtained which lists students who have started a topic (started topic report).
3. The teacher/group ID card is used to identify the teacher and instructional group when establishing and modifying instructional groups.
4. The pupil action card is used to place students into instructional groups, and it is also used in conjunction with the pupil performance record request form to obtain individual progress sheets.
5. The pupil performance record request forms enable summaries of pupil performance to be obtained. These achievement profiles are either in terms of a given topic (topic checklist report) or a given level (group or unit record card). Such information can be summarized for an administrative unit or an instructional group.

Six types of reports have also been identified: (1) the instructional grouping recommendation report, (2) the topic deficiency report, (3) the started topic report, (4) the individual progress sheet, (5) the group (or unit) record card, and (6) the topic checklist report.

The function, information content, and the periodicity of the forms and reports currently proposed for the computer management of DMP are summarized in Appendix C.

The WIS-SIM model presented in Chapter I is applicable at all levels of IGE school management. The information flow presented in this chapter for DMP has dealt with the information provided to the unit-level decision makers--staff and students of the I & R unit. The reports needed by the IIC and the SPC have yet to be specified. The information required to provide progress summaries and achievement statistics for various administrative levels exists within the data base. Requirements for management by exception reporting need to be specified to permit computer monitoring of progress at the individual student level, at the building level, and on a district-wide basis. Educational goals for various subgroups of the student population need to be established and monitored.

IV

PROPOSED DEVELOPMENTAL STRATEGIES AND SYSTEM DESIGN CONSIDERATIONS

Although the CMI systems for DMP and WDRSD are the prime concerns at this point in time, several other WIS-SIM applications are being conceptualized and developed. These cover a broad range of educational topics and ideas. Their development and eventual implementation are scheduled to occur through 1978 as indicated in Figure 25. This chapter will briefly discuss each of these separate areas of CMI application in terms of its content and development schedule. A chronological format will be followed in this discussion. The scheduling of developmental activities is related both to the maturity of the IGE element or curricular component and the envisioned amount of computer support that will be required to manage the element or component.

PHASE I—1974-1975 PILOT TESTS

Currently, fairly mature IGE elements and curriculum components include the IGE instructional programing model, Individually Guided Motivation (IGM), WDRSD, the Prereading Skills Program, and DMP. Initially, CMI systems for DMP and WDRSD will be developed. A system design for managing WDRSD, which incorporates the requirements of the instructional programing model and IGM, was discussed in Chapter II. Similarly, a design for the computer management of DMP was discussed in Chapter III. The phase I developmental activities will culminate with the pilot testing of DMP and WDRSD as separate entities during the 1974-75 school year.

Some elements of IGM have already been incorporated in the WDRSD design,

PONENT D6: COMPUTER APPLICATIONS FOR IGE

Conduct Predevelopment Work

10.01 Needs and Specifications for IGE Instructional Components

10.02 Needs and Specifications for IGE Elementary Schools

10.03 Needs and Specifications for IGE Environmental Education

10.04 Needs and Specifications for IGE Secondary Schools

20 Develop IGE Management System Theoretical Model

20.01 Computer Management System for IGE Instructional Components (Theoretical Paper)

20.02 Computer Management System for IGE (Paper)

20.03 IGE Management System Monograph

30 Develop IGE Management System Materials and Procedures

30.01 DMP Management System Materials and Procedures

30.02 WDRSD Management System Materials and Procedures

30.03 Prereading Management System Requirements

30.04 Environmental Education Management System Materials and Procedures

30.05 IGM Management System Materials and Procedures

30.11 Home-School Relations Materials and Procedures

30.20 IGE Administrative Data System Materials and Procedures

30.21 Research and Evaluation Data System Materials/Procedures

30.30 IGE Management System Materials and Procedures

60 Evaluate Materials/Procedures

60.01 DMP Management System Pilot Test Report

60.02 WDRSD Management System Pilot Test Report

60.03 IGE Management System Pilot Test Report

60.04 IGE Management System Field Test

80 Disseminate/Implement

80.01 74 Report of Dissemination/Implementation Activities

80.02 75 Report of Dissemination/Implementation Activities

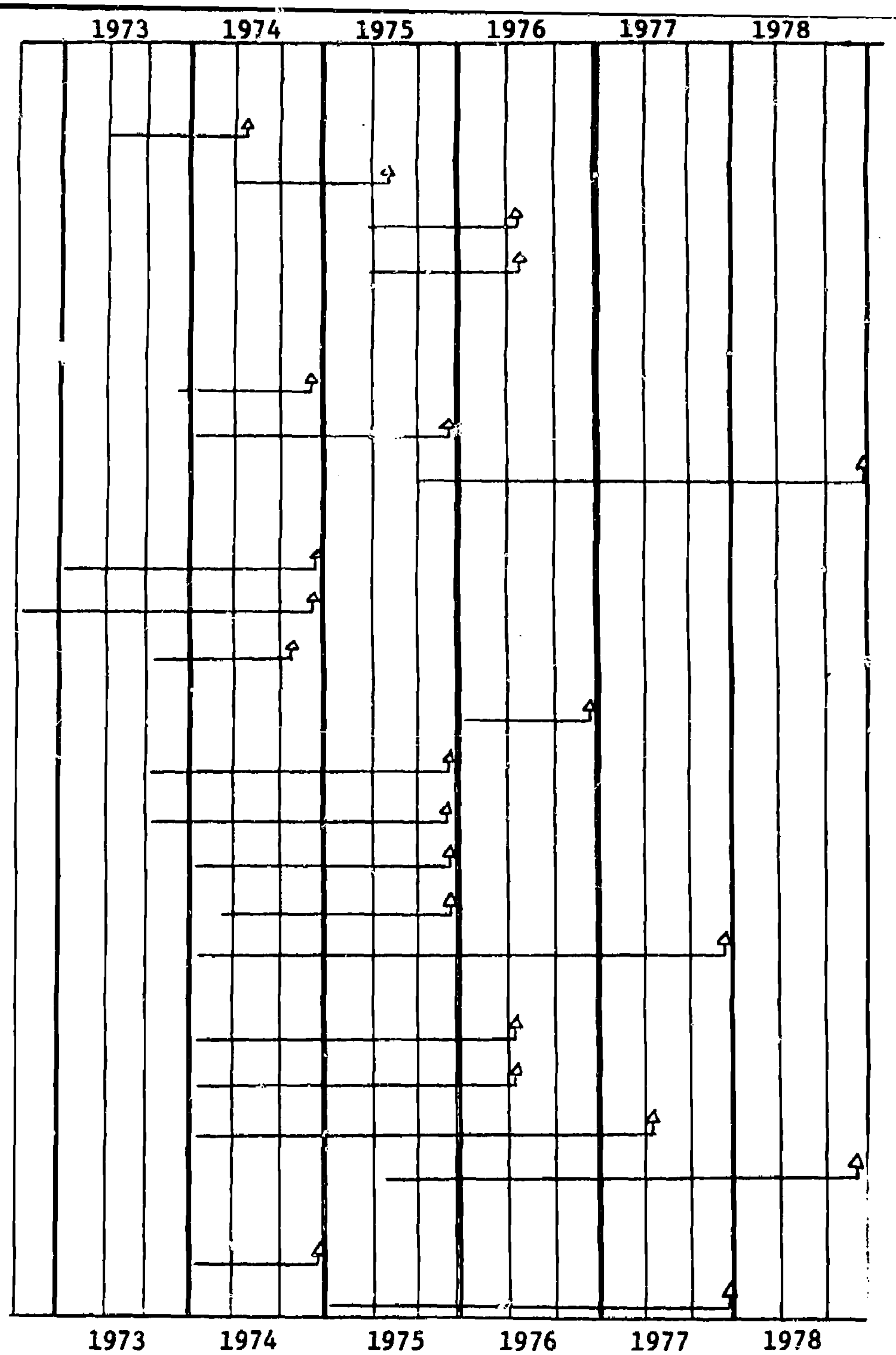


Figure 25. Milestones for computer applications for IGE.
(The length of a line indicates the duration of an activity.)

but IGM will undergo a more systematic development during phase II. Although the Prereading Skills Program is fairly mature at this time, its management requirements will be further assessed in 1974 before a final judgment is made as to when and to what extent it should be included in the CMI developmental effort. (The nature and characteristics of the Prereading Skills Program and IGM are summarized below.)

The Prereading Skills Program utilizes an effective record-keeping system which permits the teacher to easily determine where each pupil stands in the program and to identify pupils with common skill deficiencies. The record-keeping is based on a sorting system utilizing edge-notched cards. At this time, it has not been determined if there would be a significant payoff to automating the record-keeping function. Automation does not seem to hold promise for increasing the quality of the decision-making process. Also, the amount of data kept does not appear to warrant the implementation of an automated system.

A decision to implement WIS-SIM with the Prereading Skills Program would probably be justified on the basis of continuity of program management between Prereading and WDRSD. Data on pupil performance in the program is probably useful in placing pupils in WDRSD. There is evidence (Hubbard, 1973) to support the notion that if a student masters the prereading skills, it can be assumed that he has also mastered Level A of WDRSD.

The system of IGM is intended to assist teachers in getting children to want to learn and to become increasingly self-directed and responsible for their learning (Klausmeier et al., 1973). The term <u>individually guided</u> is used to emphasize the individual pupil, rather than the class, as the instructional unit. Four procedures provide the main means for aiding children low in motivation, achievement, or self-direction:

1. Adult-child conferences to promote independent reading. Children who read no more than their assignments can be motivated to read for enjoyment and to learn independently through adult-child reading conferences.
2. Teacher-child goal-setting conferences related to subject matter learning. The objectives of goal-setting conferences are to increase the motivation of the student in a particular subject area, to bring about higher achievement in the subject area, and to increase the self-direction of the student by teaching him to set realistic goals.
3. Guiding older students as tutors of younger students. In regularly scheduled sessions, a student tutor provides assistance to a child one to four years younger than himself. In the tutoring sessions, the older child guides the younger child's practice of skills or his independent study activities. Tutoring is carried out as part of the younger child's regular instructional program in a particular subject matter area.
4. Small-group conferences to encourage self-directed prosocial behavior. These conferences apply IGM principles of modeling, feedback, reinforcement, and goal setting to student self-direction and conduct.

PHASE II—1975-1976 PILOT TESTS

Phase I activities conclude with the pilot testing of DMP and WDRSD as separate activities in the 1974-75 school year. In contrast, the thrust of the phase II developmental activity will be to integrate IGE elements and curricular components which are appropriately mature and warrant inclusion in WIS-SIM. Thus, phase II will integrate WDRSD, DMP, IGM, and the Home-School-Community Relations component. In addition, phase II will include the development and pilot testing of IGE Administrative Data System procedures and materials as well as Research and Evaluation Data System materials and procedures.

The Administrative Data System will be concerned primarily with a pupil information management system that will satisfy school, district, and state information needs relative to student achievement in educational programs. Conventional school business applications, such as school personnel, finance, and facilities, are beyond the scope of this project, at least through 1978.

The Research and Evaluation Data System will be responsive to the research and evaluation components of IGE. It will be designed to provide information that will be helpful in refining IGE components and that will lead to improved second-generation components. The Research and Evaluation Data System will also be designed to provide information that will be useful to personnel in implementing IGE as well as in providing data to the IIC and SPC which will aid in selecting among competing instructional strategies.

The phase II developmental effort will culminate with a pilot test in the 1975-76 school year. The system which will be pilot tested will integrate WDRSD, DMP, IGM, the IGE Administrative Data System, the Research and Evaluation Data System, Home-School-Community Relations, and possibly the Prereading Skills Program. (A description of the nature and characteristics of the Home-School-Community Relations component follows.)

The method of analysis required to derive the CMI requirements for Home-School-Community Relations (HSCR) differs in a significant way from that which is appropriate for other IGE components. In other IGE components, the emphasis is to determine what information elements about students and their performance are required by the student, his teachers, and other members of the school staff. These information elements are identified by the developers in the CMI activity who monitor the development of the various IGE components for purposes of deriving CMI requirements. In HSCR, the emphasis is to determine what information elements are required to generate the interest and encouragement of parents and other adults whose attitudes influence pupil motivation and learning. It is necessary for the developers of HSCR to monitor the development of CMI activities to determine what existing information elements and reports would be appropriate for transmittal to parents. It is also likely that the developers of HSCR might involve the parents in some classroom activities that are being implemented by the CMI system. A case in point would be establishing pupil performance goals in parent-student-teacher goal-setting conferences as a part of the instructional programing model.

One unique element of the HSCR is a series of simulation-information (simformation) activities designed to acquaint parents with the organizational struction of IGE and the various curriculum components. It is felt (Fruth & Moser, 1973) that such orientation will increase cooperation and collaboration between home and school in that parents' understanding of their responsibilities at home will begin with the knowledge of what happens in the school. It is also felt that the simformation modules will prove useful in training volunteers in the community as classroom aides. Associated with the simformation modules will be assessment instruments to measure attitudinal changes as well as the level of factual information acquired. Such parental measures might be useful to teachers in terms of conducting teacher-parent conferences. Such information might also be useful in identifying volunteer classroom aides.

PHASE III--1976-1977 FIELD TEST

The development activities will culminate in phase III in a field test of the IGE Computer Management System during the 1976-77 school year. The IGE elements and components which were developed in phase II will undergo further refinement. In addition, materials and procedures will be developed for managing Environmental Education. Environmental Education is, at this time, in an early stage of development, but it does not seem to pose any major problems for being incorporated into the IGE computer management system.

Another ongoing project, IGE/MUS-S, an extension of IGE/MUS (IGE in the multiunit school) to the secondary school level, does pose unique problems. For one thing, the secondary school system of education that is eventually formulated by the project will likely abandon the multiunit school organization pattern as found in the elementary school (Koritzinsky & White, 1973), and thus, there may be little transfer of management concepts and procedures from one level to another. Also, no curricular components for utilization at the secondary level have been identified. When such curricular components are identified or developed, a great deal of effort will be necessary to analyze and determine the requirements needed to support them. In 1975, a preliminary needs and specifications paper will be developed for the IGE/MUS-S component. It is extremely difficult to determine the amount of effort or the time required to perform the required developmental work. At this time, it appears to be inappropriate to plan or make projections for an IGE/MUS-S computer management system. Thus, the current schedule and the projected budgetary requirements for the Computer Applications for IGE project do not include any developmental activity related to MUS-S other than the paper mentioned above.

CMI DESIGN GOALS

A number of design goals are guiding the Wisconsin R & D Center's WIS-SIM developmental activities. The following five goals will be among those receiving initial emphasis: (1) to facilitate the learning environment for each child in terms of the instructional and organizational requirements of IGE; (2) to provide information which is useful to educational decision makers at the unit, school, and district level; (3) to make minimal demands on teachers to "learn" the system; (4) to make minimal demands on teachers to perform tasks which are different from normal classroom activities and, where possible, to reduce the paperwork requirements of school personnel; (5) to improve communication with and the quality of student achievement reporting to parents; and (6) to make computer management of instruction available to a large number of the nation's IGE/MUS's.

The instructional and organizational requirements of IGE were developed in Chapter I. In Chapter II, a preliminary WIS-SIM design for the reading program (WDRSD) was presented, and in Chapter III, a preliminary WIS-SIM design for the math program (DMP) was presented. The information flows depicted in Chapters II and III manifest a responsiveness to the instructional and organizational requirements of IGE. Similarly, the information flows described the information elements which are made available to decision makers at various organizational levels. The preliminary designs described in Chapters II and III demonstrate design features which make minimal demands on teachers to learn the systems and to perform tasks which are different from normal classroom activities.

The nature of the data inherent in CMI systems, their accessibility, and the report generation capability of the computer have the potential for greatly enhancing communication between home and school. Achievement can be reported in terms of behavioral objectives, and thus parents can become increasingly knowledgeable about the educational goals of the school and the progress of their children in meeting these goals. Since the generation, printing, and mailing of reports home can be highly automated, decisions as to the frequency and detail of reports need not be based on trade-off considerations regarding appropriate utilization of the teacher's time. Also, the computer makes management by exception reports feasible in the school-home reporting scheme.

An obvious response to the goal of making computer management of IGE available to a large number of the nation's schools is to develop a system which can be implemented on a computer configuration affordable by a large number of schools. This approach is not viable in that it seems unlikely that school systems will acquire computers for the sole purpose of managing education. A more promising approach is to design a system which is compatible with existing configurations. Therefore, it becomes important to consider what type of computer configurations are currently most available to the nations schools and what kind of configurations are likely to become available in the foreseeable future. Delivery systems (the methods and procedures by which data generated in the schools can be entered into the computer and the means by which computer-generated reports can be delivered to the schools) must be developed which are compatible with such popular systems.

Currently, the most popular type of computer configuration in schools is one which was originally acquired to do administrative data processing in a batch mode of operation and hence has little or no on-line capability. In order to service such schools, it is necessary to utilize a courier service to deliver data and reports between the classroom and the computer facility. A courier delivery service approach will be evaluated during a pilot test conducted during the 1974-1975 school year to determine whether such a delivery system is feasible and whether it is sufficiently responsive to meet the turn-around requirements of IGE. It is likely that the courier service approach will be dependent upon the proximity of schools to the computer facility. Its success may also be dependent upon the existence of a courier service which has functions in addition to that required by the CMI system. A courier service established solely for purposes of CMI may be difficult to justify on a cost-effectiveness basis in the operational environment.

Although the courier service approach will be studied during the 1974-75 pilot tests, the evaluation and development of on-line procedures will be emphasized. On-line systems are not currently characteristic of school computer configurations, although they are very probably the wave of the future. On-line capability will evolve in schools in a number of ways. Current batch systems will be upgraded to on-line capability or will be replaced by systems that have such capability. On-line minicomputer systems which are being acquired for instructional data processing are becoming increasingly popular. These systems are being utilized to teach students programing as well as to support gaming and simulation exercises and drill and practice CAI. At present, these systems do not have the mass storage capacity to support CMI. However, these systems are also being upgraded and replaced by on-line minicomputer systems which do have greater mass storage capacity. The Wisconsin R & D Center's min[illegible] system provides one vehicle for evaluating on-line procedures [illegible]logy.

On-Line System Design Considerations

The terminals in the schools will initially consist of an optical mark-sense card reader and a 30-character-a-second teleprinter with keyboard. Data will generally be entered at the schools either by means of the mark-sense card reader or, on occasion, by means of the keyboard. Reports generated will be printed on the school's teleprinter. The terminals will be connected to the schools via the dial-up telephone network.

A number of degrees of freedom on how responsive the system will be are available to the designer. For example, all of the school files could be resident on disc packs that are mounted during all of the school day or during that part of the school day when a particular school is allowed access to the system. The Wisconsin R & D Center's minicomputer configuration includes two removable disc pack drives; each disc pack is capable of storing 29 megabytes. When the school dials up, all its files are on-line. Input from the school is utilized as it is received to update files, and the resulting reports are generated and transmitted to the schools as quickly as the processing can be accomplished. Although this first method is highly responsive to all user inputs and requests, it is limited to servicing the number of schools whose files can be simultaneously kept on-line.

An alternative method is not to have any of the school files on-line but to accept merely the input from the schools and store it on the disc pack mounted on a disc drive. When processing time becomes available, the operating system would notify the computer operator via the system teletype to mount the appropriate disc pack on a second disc drive. The file would then be updated, and the appropriate report would be generated and transmitted to the school. This alternative method, of course, does not have the response time which is characteristic of the first method. However, it can service many more schools with a fixed amount of mass storage than can the first method. It is limited by the amount of processing time available during the 24-hour period. In most operational environments, available processing time will be less of a premium than the available on-line storage.

A hybrid of the two methods has a great deal of appeal. In the hybrid approach, a storage hierarchy concept will be employed. Data related to real-time response requirements will be stored on an on-line disc pack. Data related to lower priority response requirements will be on removable disc packs that are not kept on-line. Data which have very low response time requirements will be kept on tape which is also stored off-line. When the tape data are needed, the tape will be mounted and processed. This hybrid method appears to combine the best of both worlds. It is responsive as it needs to be, and it has potential for servicing a large number of schools. However, it requires additional analysis in order to assign proper priorities to functions and a more sophisticated data structure to appropriately link records.

Minimum Disruption of Teaching Function

Making minimal demands on teachers to learn the system and to perform tasks which are different from normal classroom activities are major design goals. Ideally, data generated as a result of normal classroom activity should be recorded in a form which can be directly entered into the computer. The aspect of source data collection which is usually emphasized is the ability to skip the intermediate step of converting data into machine-readable form. This results in a saving in keypunching and a decrease in turn-around time. Source data collection is also appealing because it permits the implementation of an on-line system without requiring the school staff to become knowledgeable of conventional computer procedures.

Procedures based upon a source data collection concept utilizing optical mark-sense technology are being developed and promise to be minimally disruptive of normal classroom activity. Although the school terminal has a full alphanumeric keyboard, the design goal is to have nearly all of the inputs made via the optical mark-sense reader. The keyboard will be used for infrequent inputs and queries and for newly emerging functions for which there has not been sufficient time to develop forms. The mark-sense formats are being engineered to make minimal demands on the teacher in terms of both the number of entries required per transaction and the amount of training required to become proficient in their use.

We do not consider the mark-sense reader we have currently acquired for implementation in schools to be our ultimate selection. It is limited in that it can only read a Hollerith-size card. Thus, it does not meet our source data requirement of handling data as it is ordinarily generated in the classroom. In the classroom, data is usually recorded on 8 1/2 x 11 sheets. In our courier service pilot tests, we will be making use of an optical mark-sense reader at a computer facility which is capable of reading 8 1/2 x 11 sheets. But at the moment, such readers are too expensive to place in each school. However, the industry claims that reasonably priced sheet scanners are currently in development and should be marketed soon.

A teleprinter is specified instead of a CRT since hard-copy is essential in many of the reports generated. Even if both a CRT and a hard-copy printer could be made available at a reasonable cost, we cannot at this time envision any particular advantage in this application in having a CRT. In addition to its report-generating capabilities, the teleprinter is an impact printer which will permit the generation of ditto masters of instructional materials. It also has an upper- and lower-case character set which will enhance readability and breadth of applications.

System Transportability

As previously stated, a major design goal is to make computer management of IGE available to a large number of the nation's schools. In line with this goal, it was decided that the project would not concentrate on the development of a single system which could be transported into a school district. Such an approach would prove nonproductive since it is unlikely that a school district would acquire a computer system mainly to support CMI. Thus, the thrust of the project will be to develop products which will be useful in a large number of school computer configurations--configurations that are currently available to schools and those that will become available in the near future.

There are two dimensions to developing products which will be useful in a large number of school computer configurations. One dimension relates to the degree of specificity that should be designed into a product. If a product is highly specific for a particular computer configuration or class of computer configurations, it could be implemented in those computers with no or a minimum amount of modification; however, such a product would have little applicability to other systems. In contrast, a product that has a high degree of generality could be applicable to a large number of systems, but implementation on each type of system would require considerable modification. Thus, in order to make wise trade-off decisions in terms of this dimension of transportability, it is necessary to know the types of computer systems becoming available to school districts.

Since a turnkey system development strategy is not to be pursued, a second dimension of transportability is to define and develop types of products which will have wide applicability in different types of computer configurations. It is currently envisioned that such products will take the form of a model for CMI, system requirements, system procedures, functional flow charts, data requirements, concepts of data base organization, input and report formats, and on-line and communications procedures and concepts. Although software, which is developed to support pilot and field tests, will be made available to any system which might have use for it, software development does not fit our concept of a product that has wide applicability.

In order to become knowledgeable of the substance and form of products which would be applicable to computer configurations available to schools and in order to develop and evaluate such products in realistic settings, two developmental thrusts are proposed. One line of development will be a Wisconsin R & D Center in-house effort which will provide services to school districts and allow for continued monitoring, evaluation, and modification of the on-going system. The second line of development will be modeled after the cooperative CMI developmental effort between the R & D Center and the Duluth Public Schools. It is an activity which assists school districts and other agencies who have computers of their own to manage components of IGE. The in-house effort has a high potential for yielding practical research findings as well as providing assistance to innovative school districts. It tends to ensure that districts with existing computer facilities will be able to manage IGE in a manner which is highly compatible with, and nondisruptive of, their existing file structure, programing conventions, and operating procedures. It also ensures that there are operational systems in the field before the R & D Center completes its formal developmental cycle.

The pilot test and field test populations will, therefore, consist of a mix of "in-house" schools and "cooperative" schools. The manner in which the pilot and field testing of the "in-house" schools is conducted will closely conform to established Wisconsin R & D Center practices. Much of the required equipment, materials, software design, data processing, and in-service training, materials, and evaluation will be provided by the R & D Center. In contrast, the "cooperative" schools will themselves provide the necessary staff, materials, computer services, equipment, and software for conducting the study. The R & D Center will provide consulting services in the areas of overall study design, data file structure design, design of computer input and output formats, implementation procedures, and limited on-site evaluation of user acceptance. The Center, however, will take prime responsibility for generating the test report.

Pilot and Field Test Implementation

The need for developing and evaluating both batch and on-line procedures and techniques has been discussed in previous sections of this chapter. Since WDRSD and DMP will be pilot tested as separate entities in the 1974-1975 school year, cost savings would be realized if one of these components served as the vehicle for developing and evaluating batch capabilities and the other component was utilized for on-line development and evaluation. Since DMP has more stringent turn-around requirements than WDRSD, an on-line system will be utilized for DMP in the 1974-75 pilot tests and a batch system will be utilized for WDRSD. In WDRSD, most of the assessment is by means of paper-and-pencil criterion-referenced tests which are administered on an average of every two or three weeks. DMP has three to four times as many behavioral objectives as WDRSD, and much of the assessment is made more frequently than in WDRSD.

In the 1975-76 pilot test and in the 1976-77 field test, the various IGE components and elements will be integrated into a single system, and thus, it will be necessary to either pilot test both a batch and an on-line system or to implement a hybrid system. In a hybrid system, some schools will be on-line and other schools will have their inputs and reports delivered by a courier service. If the hybrid system approach is selected, the software will be developed so as to maximize the amount of software which could be utilized in either an on-line or a batch environment.

A number of options are available to the Wisconsin R & D Center as to the computer equipment configurations to be utilized in implementing the pilot and field tests. The Wisconsin R & D Center has acquired a minicomputer and three teletypewriter mark-sense terminals for use in the schools for the 1974-75 pilot tests. Figure 26 is a block diagram of the minicomputer configuration. The minicomputer configuration operates in a multiprograming environment and supporting a CMI network is only one of its intended functions. This equipment was acquired with funds from a federal special research equipment grant associated with the construction of the Educational Sciences Unit building which houses the Wisconsin R & D Center. Approximately half of the funds have been expended, and the remaining funds are available through 1975. Some of these remaining funds will be used to acquire additional school terminals and to enhance the minicomputer configuration for the 1975-76 pilot test and the 1976-77 field test. st.

In addition to the minicomputer configuration, the Wisconsin R & D Center has available the large scale computing capability of the university's Madison Academic Computing Center (MACC). The 1974-75 pilot test of the WDRSD batch processing system will be conducted on the MACC computer; the R & D Center's minicomputer will serve as a remote job entry terminal to MACC. A

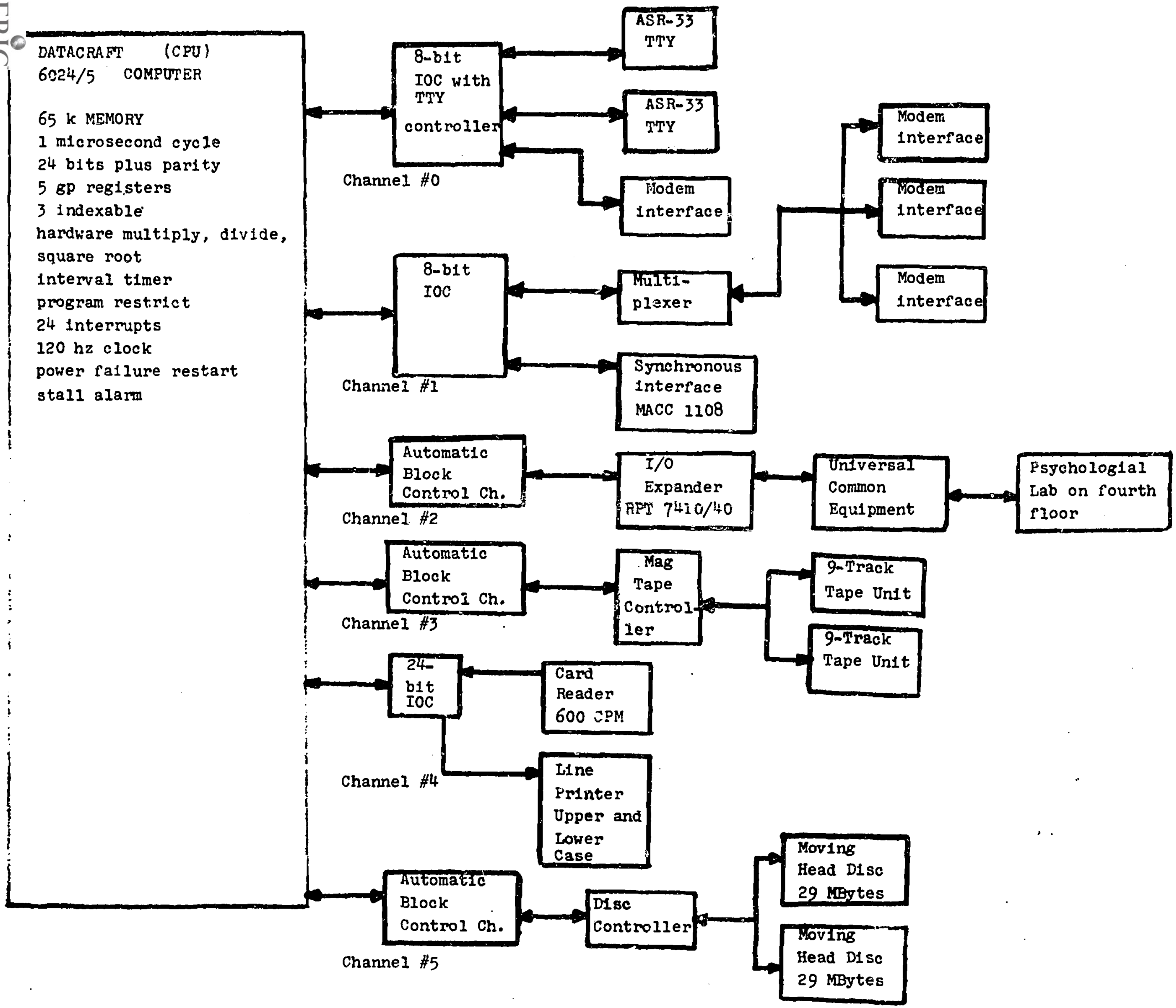


Figure 26. Wisconsin R & D Center data processing equipment as of 12/73.

courier service will deliver input forms to the R & D Center where they will be keypunched and transmitted to MACC via the minicomputer. The reports will be transmitted from MACC and printed on the R & D Center's high-speed printer for subsequent delivery to the schools by means of the courier service. Much of the software required for this system is currently available as a result of the on-going Duluth developmental effort. Since this software is written in COBOL, a high degree of transferability is expected.

The R & D Center's current minicomputer configuration will adequately support the few on-line terminals that will be required for the 1974-75 pilot test of DMP. The 1975-76 pilot test of IGE which will involve a minimum of ten schools and the 1976-77 field test of IGE which will involve a minimum of 16 terminals on-line will require more computational power. The R & D Center's minicomputer configuration could be enhanced to support these additional terminals or the R & D Center's minicomputer and the MACC computer could be configured so that the R & D Center's minicomputer would serve as a preprocessor to the MACC computer. The selection between these two approaches will in large measure depend upon whether or not the R & D Center's on-line design concepts can be supported by a stand-alone minicomputer configuration.

ADMINISTRATIVE AND RESEARCH APPLICATIONS

The CMI data which can be conveniently collected in a WIS-SIM system has high potential for being productive in learning research and curricular development studies. Deficiencies in curricular material could be detected, and competing instructional strategies could be evaluated. Appropriate sequencing of prerequisites could be verified, and rates for obtaining mastery for various objectives could be precisely determined. In addition, WIS-SIM may be used as a data collection mechanism for experimental research in the classroom setting. The administrative and research capabilities of WIS-SIM will be explored in greater detail in a later paper.

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APPENDIX A

WDRSD DATA ELEMENT REQUIREMENTS

APPENDIX A

WDRSD DATA ELEMENT REQUIREMENTS

Field Number	Data Items	Size Dig./Char.	Type A,N A/N	Remarks/Code[a]
1	District number	3	N	
2	School number	2	N	
3	Student number	10	N	Social Security Number (if available) plus check digit (LSD)
4	Student name	20	A	LAST,△FIRST△I.
5	Student's birth date	6	N	DDMMYY
6	Grade	2	N	00 - 12
7	Student's sex	1	A	M=Male F=Female
8	Teacher's name	17	A	LAST,△I.
9	1st semester anticipated number of Word Attack Skills to be mastered--Actual number of skills mastered	4	N	NN Anticipated NN Actual
10	2nd semester anticipated number of Word Attack Skills to be mastered--Actual number of skills mastered	4	N	NN Anticipated NN Actual
11	1st semester anticipated number of Study Skills to be mastered--Actual number of skills mastered	4	N	NN Anticipated NN Actual

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APPENDIX A CONT.

Field Number	Data Items	Size Dig./Char.	Type A,N A/N	Remarks/Code[a]
12	2nd semester anticipated number of Study Skills to be mastered--Actual number of skills mastered	4	N	NN NN Anticipated Actual
13	1st semester anticipated number of Comprehension Skills to be mastered--Actual number of skills mastered	4	N	NN NN Anticipated Actual
14	2nd semester anticipated number of Comprehension Skills to be mastered--Actual number of skills mastered	4	N	NN NN Anticipated Actual
15-21	Word Attack Level A (7 skills)	6	A/N	Char. 1--Total attempts 0-9 Char. 2-3--Date 00-52 Char. 4-5--00-99% score; TC, TO, NM Char. 6--M (mastery)
22	Mastery of all Level A skills	1	A	M=mastery
23-35	Word Attack Level B (13 skills)	6	A/N	See remarks for Fields 15-21
36	Mastery of all Level B skills	1	A	M=mastery
37-54	Word Attack Level C (18 skills)	6	A/N	See remarks for Fields 15-21

CONTINUED

APPENDIX A CONT.

Field Number	Data Items	Size Dig./Char.	Type A,N A/N	Remarks/Code[a]
55	Mastery of all Level C skills	1	A	M=mastery
56-62	Word Attack Level D (7 skills)	6	A/N	See remarks for Fields 15-21
63	Mastery of all Level D skills	1	A	M=mastery
64-66	Study Skills Level A (3 skills)	6	A/N	See remarks for Fields 15-21
67	Mastery of all Level A skills	1	A	M=mastery
68-71	Study Skills Level B (4 skills)	6	A/N	See remarks for Fields 15-21
72	Mastery of all Level B skills	1	A	M=mastery
73-83	Study Skills Level C (11 skills)	6	A/N	See remarks for Fields 15-21
84	Mastery of all Level C skills	1	A	M=mastery
85-98	Study Skills Level D (14 skills)	6	A/N	See remarks for Fields 15-21
99	Mastery of all Level D skills	1	A	M=mastery

CONTINUED

APPENDIX A CONT.

Field Number	Data Items	Size Dig./Char.	Type A,N A/N	Remarks/Code[a]
100-116	Study Skills Level E (17 skills)	6	A/N	See remarks for Fields 15-21
117	Mastery of all Level E skills	1	A	M=mastery
118-129	Study Skills Level F (12 skills)	6	A/N	See remarks for Fields 15-21
130	Mastery of all Level F skills	1	A	M=mastery
131-140	Study Skills Level G (10 skills)	6	A/N	See remarks for Fields 15-21
141	Mastery of all Level G skills	1	A	M=mastery
142-191	Comprehension Skills (approximately 50 skills)	6	A/N	See remarks for Fields 15-21
192	Last skill mastered	6	A/N	Char. 1--skill area A=Word Attack S=Study Skills C=Comprehension Char. 2--Level A-5 Char. 3-4--Skill 00-81 Char. 4-5--Date 00-52
193	Number of skills at beginning of year (baseline)	3	N	NNN

CONTINUED

APPENDIX A CONT.

Field Number	Data Items	Size Dig./Char.	Type A,N A/N	Remarks/Code[a]
194	Active record field	1	A	Blank = active I = inactive

[a]Total number of characters per student is 1,102.

APPENDIX B

SUMMARY OF FORM AND REPORT UTILIZATION
FOR COMPUTER MANAGEMENT OF WDRSD

SUMMARY OF FORM AND REPORT UTILIZATION
FOR COMPUTER MANAGEMENT OF WDRSD

Input Form or Report	Function	Information Content	Frequency or Periodicity
Baseline performance data (INPUT FORM)	1. Enter the results from the mass administration of WDRSD criterion-referenced tests into the computer. or 2. Transfer WDRSD criterion-referenced test performance data from a manual system into the computer system.	1. Skill area 2. School 3. Grade or unit 4. Teacher 5. Date form completed 6. Student number 7. Student name 8. Level completed 9. Level currently being worked on 10. Raw scores for tests taken at current level	After break-in testing or when a manual management system is phased into a computer-supported one
Raw test scores form (INPUT FORM)	Enter the results from the administration of one or more criterion-referenced tests per student.	1. School (computer generated) 2. Teacher (computer generated) 3. Level (computer generated) 4. Date form completed 5. Student number (computer generated) 6. Name (computer generated) 7. Skill area 8. Level and skill 9. Raw score	Once a week, if appropriate
Expectations of student performance (INPUT FORM AND REPORT)	Initial utilization is a combination report and input form. The teacher is informed of the total number of skills the student has mastered at the beginning of the year.	1. Skill area (computer generated) 2. School (computer generated 3. Unit (computer generated) 4. Teacher (computer generated) 5. Date form completed 6. Student number (computer generated) 7. Student name (computer generated)	The form, which contains students' names and baseline data (number of skills as of beginning of year) is issued to the teacher at the beginning of the year. The teacher enters number of skills to be mastered at end of the first semester and by end of the year. The report is updated

CONTINUED

APPENDIX B CONT.

Input Form or Report	Function	Information Content	Frequency or Periodicity
		8. Baseline skill mastery (computer generated) 9. Expected number of skills to be mastered 10. Actual number of skills mastered first semester (computer generated) 11. Total number of skills mastered by the end of the first semester (computer generated) 12. Expected number of skills to be mastered by end of school year 13. Actual number of skills mastered by end of school year (computer generated) 14. Total number of skills mastered by end of school year (computer generated)	at the end of the first semester and end of the school year with the total number of skills mastered to date and the number of skills mastered during the reporting period.
Specific grouping report (REPORT)	List students that are eligible for taking a specific skill.	1. School 2. Skill 3. Area 4. Date of report 5. Prerequisite skills 6. Student number 7. Student name 8. Grade or unit 9. Number of previous attempts 10. Date of last attempt 11. Score (percent) of last attempt	Whenever a specific grouping request is made

CONTINUED

Input Form or Report	Function	Information Content	Frequency or Periodicity
Unit performance profile (REPORT)	Summarize the performance data on each skill for each student in the unit. It is utilized to monitor performance of students.	1. School 2. Unit 3. Skill area 4. Date of report 5. Student number 6. Student name 7. List of all tests in unit by number 8. Indication of relationships between and among tests in the unit 9. Indication of mastery or test score if not mastered listed by test number	Issued weekly
Group instructional objectives (REPORT)	Summarizes pupil performance data and teacher expectations in terms of the top third, the middle third, and the bottom third of a group. Groups so summarized include single units and units within a district that are at the same level. These summaries enable teachers, principals, and central office personnel to quickly see the performance levels and expectation levels within these groups for determining the general progress of units throughout the year.	1. School 2. Unit (individual unit, unit at same level within district) 3. Skill area BASELINE PROFILE 4. Average number of skills mastered by top, middle, and bottom group 5. Approximate skill level for top, middle, and bottom group EXPECTED PROFILE FIRST SEMESTER 6. Number of skills to be mastered by top, middle, and bottom group 7. Approximate skill level for top, middle, and bottom group	The group instructional objective report is issued three times a year. The first report is issued at the beginning of the year and it includes baseline performance data and teacher expectations for the first semester and end of school year. At the end of the first semester, the report is updated to include first semester performance. The year-end data report update includes year-end performance

CONTINUED

Input Form or Report	Function	Information Content	Frequency or Periodicity
		ACTUAL FIRST SEMESTER PROFILE 8. Number of skills mastered by top, middle, and bottom group 9. Approximate skill level for top, middle, and bottom group EXPECTED PROFILE YEAR END 10. Number of skills to be mastered by top, middle, and bottom group 11. Approximate skill level for top, middle, and bottom group ACTUAL YEAR-END PROFILE 12. Number of skills mastered by top, middle, and bottom group 13. Approximate skill level for top, middle, and bottom group	
Diagnostic report--students who have not mastered a skill for six or more weeks (REPORT)	This management by exception report lists the students who have not mastered a skill for six or more weeks.	1. School 2. Teacher 3. Date of report 4. Student number 5. Student name 6. Last skill mastered 7. Date mastered	Issued weekly, as appropriate
Diagnostic report--students who have deviated from anticipated number of skills (REPORT)	This management by exception report identifies students who have exceeded or failed to meet teacher-student expectations by two or more skills.	1. School 2. Teacher 3. Date 4. Student number 5. Student name	Issued twice a year; end of first semester and end of school year

CONTINUED

Input Form or Report	Function	Information Content	Frequency or Periodicity
		6. Anticipated number of skills to be mastered during reporting period (first semester or year-end) 7. Actual number of skills mastered during reporting period (first semester and year-end) 8. Difference between anticipated and actual performance	

APPENDIX C

SUMMARY OF FORM AND REPORT UTILIZATION
FOR COMPUTER MANAGEMENT OF DMP

SUMMARY OF FORM AND REPORT UTILIZATION
FOR COMPUTER MANAGEMENT OF DMP

Input Form or Report	Function	Information Content[a]	Frequency or Periodicity
Instructional grouping recommendation (REPORT)	Used as a basis to establish appropriate instructional experiences.	1. Topic 2. Prerequisites for topic 3. Student name (those ready for topic)	As requested
Topic deficiency report (REPORT)	Pinpoints specific difficulties with objectives and indicates the sequence of objectives required to master a given topic.	1. Unit 2. Topic (not ready for) 3. Previous topics not mastered 4. Objectives for previous topics 5. Student name 6. Rating	As requested
Grouping information request (INPUT FORM)	Used to request the instructional grouping recommendation report and the topic deficiency report.	1. Instructional group/unit 2. Level 3. Topic 4. Type of student (not ready/ready/ started) 5. Arrangement of data (by topic/ by name)	As requested
Individual progress sheet (REPORT)	Useful in student-teacher conferences on measurable behavioral objectives as well as in reports to parents.	1. Date of report 2. Level 3. Student name 4. Topic (number and name) 5. Objective (number and name) 6. Ratings (P, N, M, NA) 7. Date of rating	
Group record card (REPORT)	Enables school personnel to continually monitor achievement of subgroups of the student population and to make judgments	1. Level 2. Instructional grouping ID 3. Date of report 4. Topic 5. Objective 6. Student name	

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APPENDIX C CONT.

Input Form or Report	Function	Information Content[a]	Frequency or Periodicity
	about the effectiveness of particular curricular material or teaching strategies.		
Pupil performance record request (INPUT FORM)	Used to request the individual progress sheet, the group record card, or the topic checklist.	1. Type of report requested (topic checklist or group record card) 2. Instructional grouping ID 3. Criterion (M or P, M only) 4. Instructional grouping ID 5. Level 6. Topic	
Objective checklist (INPUT FORM)	Used to input all assessment data for each objective (one card per objective).	1. Level 2. Topic 3. Objective 4. Instructional grouping ID 5. Student name (computer generated) 6. Rating (N, P, M)	
Topic checklist (REPORT)	An achievement profile on a given topic.	1. Topic 2. Instructional grouping ID 3. Date of report 4. Objective (number and name) 5. Student name 6. Rating (N, P, M, NA)	Generated automatically following an assessment update by an objective checklist or as requested by a pupil performance record request
Teacher/group ID (INPUT FORM)	Used with the pupil action card to form new instructional groups and to modify existing ones. Identifies teacher to be responsible for a group.	1. Teacher name (computer generated) 2. Indication of place in card deck (first red card)	Whenever instructional groups are created or revised

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Input Form or Report	Function	Information Content[a]	Frequency or Periodicity
		3. Instructional module 4. Special Box C 5. Special Box D	
Pupil action card (INPUT FORM)	Used with the teacher group ID card to form new instructional groups and to modify existing ones. One card per student.	1. Student name (computer generated) 2. Pupil change card (mark if so) 3. Reason for card submission (add to group; remove from group; left 4. school) 5. Special Box B	

[a]NA indicates not assessed; M, mastery; P, making progress; and N, needs considerable help.